APPENDIX ‘A’

GEOTECHNICAL REPORT

Quality Engineering | Valued Relationships

WSP Canada Group Ltd.

2022 Local Streets Package 22-R-05

Prepared for:
Lissa Van Dorp
WSP Canada Group Ltd.
111-93 Lombard Avenue
Winnipeg, MB
R3B 3B1

Project Number: 1000-043-19

Date: February 26, 2022

www.trekgeotechnical.ca
1712 St. James Street | Winnipeg, Manitoba R3H 0L3 | Tel 1.204.975.9433 | Fax 1.204.975.9435

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

February 26, 2022 Our File No. 1000-043-19

Lissa Van Dorp
WSP Canada Group Ltd.
111-93 Lombard Avenue
Winnipeg, MB
R3B 3B1

RE: 2022 Local Streets Package 22-R-05

TREK Geotechnical Inc. is pleased to submit our Final Report for the geotechnical investigation for 2022 Local Streets Package (22-R-05) project.

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

Nelson John Ferreira, Ph.D., P.Eng.
Senior Geotechnical Engineer

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	AD	February 26, 2022	Final Report

Authorization Signatures

Prepared By:

Asad Dustmamatov C.E.T.
Geotechnical Engineering Technologist

Reviewed By:

Angela Fidler-Kliewer, C. Tech
Manager of Laboratory and Field Services

Reviewed By:

PROVINCE OF MANITOBA
N.J. FERREIRA
Member
22892
REGISTERED PROFESSIONAL ENGINEER

Nelson John Ferreira, Ph.D., P.Eng.
Senior Geotechnical Engineer

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877 Date: Feb 26, 2022

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1.0 Introduction

This report summarizes the results of the road investigation completed for the Local Streets Package 22-R-05 project. The project included drilling test holes along Canora Street, Downing Street, Palmerstone Avenue, Sargent Ave/Spruce St. Alley, and collecting pavement cores along Forest Park Drive, Grundy Avenue, Hume St./Kairistine Lane Alley and Telfer Street. The test hole information collected describes the pavement structure of the existing road as well as the soil stratigraphy beneath the pavement structure. The investigation was carried out following the City of Winnipeg RFP No. 476-2021 (Appendix B – Site Investigation requirement for public works street projects).

2.0 Road Investigation

The investigation included coring of pavement at 36 locations on 8 different local streets with drilling of test holes at 16 of the cored locations along four streets. WSP selected the investigation locations as shown on Figures 01 to 08 (attached) and the table below summarizes the investigation program per street.

Table 1: Road Investigation Program

Street	# of Locations	Investigation
Canora Street (Between Preston Ave and Westminster Ave)	3	Pavement Cores and Test Holes
Downing Street (Between Ellice Ave and Armoury Ave)	3	Pavement Cores and Test Holes
Palmerston Avenue (Between Ethelbert St. and Lenore St.)	6	Pavement Cores and Test Holes
Sargent Ave/Spruce St. Alley (Between Clifton St. and Ellice Ave)	4	Pavement Cores and Test Holes
Forest Park Drive (Between Sinclair St. and Airlies St.)	5	Pavement Cores
Grundy Avenue (Between Ingersoll St. and Garfield St. N.)	3	Pavement Cores
Hume St./Kairistine Lane Alley (Between Raber Rd. and Dexter St.)	6	Pavement Cores
Telfer Street N. (Between St Matthews Ave and Ellice Ave	6	Pavement Cores

The road investigation was conducted between January 26th and February 8th, 2022. The pavement structure (asphalt/concrete) was cored by Naimu Mujyambere and Asad Dustmamatov of TREK Geotechnical Inc. (TREK) using a portable coring press equipped with a hollow 100 mm or 150 mm diameter diamond core drill bits. The test holes were drilled by Asad Dustmamatov to a depth of 2.0 m below road surface by Maple Leaf Drilling Ltd. using a truck mounted drill rig equipped with 125 mm diameter solid stem augers. The sub-surface conditions were observed during drilling and visually classified by Asad Dustmamatov of TREK. Other pertinent information such as groundwater and

drilling conditions were also recorded during the drilling investigation. Disturbed (auger cuttings) samples and bulk samples retrieved during the sub-surface investigation were transported to TREK's material testing laboratory for further testing. Pavement core samples were also retrieved and logged at TREK's material testing laboratory

Core and test hole logs noted on the summary tables and test hole locations are based on UTM coordinates obtained using a hand-held GPS, and their location relative to the nearest address or intersection, measured distance from the edge of pavement, or other permanent features.

The laboratory testing program consisted of moisture content determination on all samples, as well as Atterberg limits, and grain size analysis (mechanical sieve and hydrometer methods) on select samples between 0.6 and 0.9 m below pavement as well as Standard Proctor and CBR testing. Information gathered for each street package is included in separate appendices (Appendices A to H). The information provided in the Appendices includes test hole logs, laboratory testing summary tables and results, photos of the concrete cores, and summary of pavement compressive strength.

Seven CBR's were completed on bulk samples of the soil units present below the pavement. Tests were performed on clay, silt, and a blend of clay and silt and clay material encountered within the prescribed sample depth for CBR testing and the results are shown in the table below.

Table 2: CBR Testing Summary

Sample Description	Street	Depth (m)	SPMDD (kg/m^3)	Opt. Moisture (%)	Percent Proctor (%)	Moisture Content (%)	CBR Value at 2.54 mm	CBR Value at 5.08 mm
Clay	Canora Ave (TH22-02, 03)	0.3-1.5	1611	21.7	94.8	22.7	5.5%	4.4%
Silt	Downing Street (TH22-05, 06)	0.3-1.5	1756	18.2	94.7	20.1	3.5%	2.9%
Clay	Downing Street (TH22-04, 05, 06)	0.3-1.5	1566	22.0	94.4	23.5	2.3%	1.9%
Clay	Palmerston Ave (TH22-07, 08, 09)	0.3-1.5	1565	21.5	94.5	23.3	4.6%	3.7%
Clay	Palmerston Ave (TH22-10, 11, 12)	0.3-1.5	1664	20.2	94.7	21.5	6.0%	5.2%
Clay, Silt and Clay	Sargent St/Spruce St Alley (TH22-13, 15)	0.3-1.5	1652	19.3	95.0	21.6	6.2%	4.9%
Silt	Sargent St/Spruce St Alley (TH22-14, 16)	0.3-1.5	1775	17.0	95.8	19.0	5.9%	4.8%

* Testing completed on combining grab samples from the top 1.5 m of each test hole.

The test hole logs include a description of the soil units encountered during drilling and other pertinent information such as groundwater conditions and a summary of the laboratory testing results. The soils were classified in general accordance with the Unified Soil Classification System (USCS) and the AASHTO soil classification system (American Association of state highway and transportation officials). The AASHTO system classifies soils based on laboratory testing results from Atterberg Limits and grain size testing methods (hydrometer and mechanical sieve method). Where laboratory testing was not conducted, the AASHTO classification of the soils were interpreted based on a visual assessment as indicated with a (I) on the test hole logs and attached tables. For cohesive soils, the AASHTO system uses a combination of testing results to determine the Group Index of the soils and thus, were only determined where sufficient laboratory test data was available.

Eight concrete cores were selected for concrete compressive strength breaks and the length to diameter ratio ranged between 1.05 to 1.82 for the cores collected. The core compressive strength tests were tested in accordance with CSA A23.2-14C – wet dried condition. The measured compressive strengths were also corrected based on an adapted ACI 214.4R-03 Standard to estimate the in-place concrete strengths. The table below summarizes the compressive strength results while the compressive strength testing details and the correction factor methodology are included in Appendix E, F and H.

Table 3: Concrete Core Compressive Strength Results

Core ID (Location)	Uncorrected Compressive Strength (MPa)	Corrected Compressive Strength (MPa)
PC-01 (Forest Park Drive)	57.59	61.29
PC-03 (Forest Park Drive)	63.47	69.07
PC-05 (Forest Park Drive)	59.85	66.00
PC-12 (Telfer Street North)	64.55	73.99
PC-14 (Telfer Street North)	60.70	70.17
PC-15 (Telfer Street North)	64.65	74.80
PC-18 (Grundy Avenue)	45.92	52.49
PC-19 (Grundy Avenue)	58.95	67.60

3.0 Closure

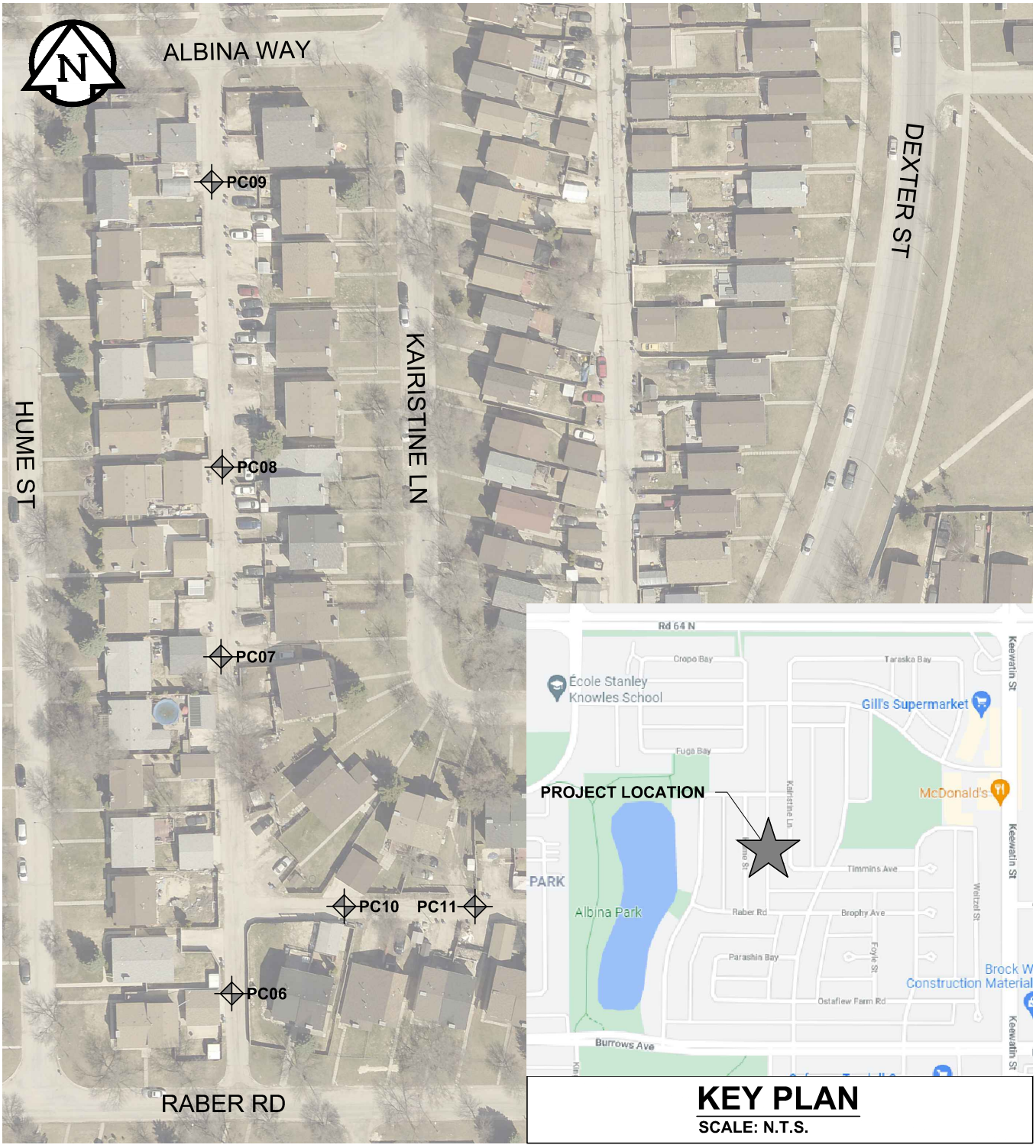
The information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly

variable across a site. If sub-surface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of WSP Canada Group Ltd. (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figures



KEY PLAN
SCALE: N.T.S.

LEGEND:

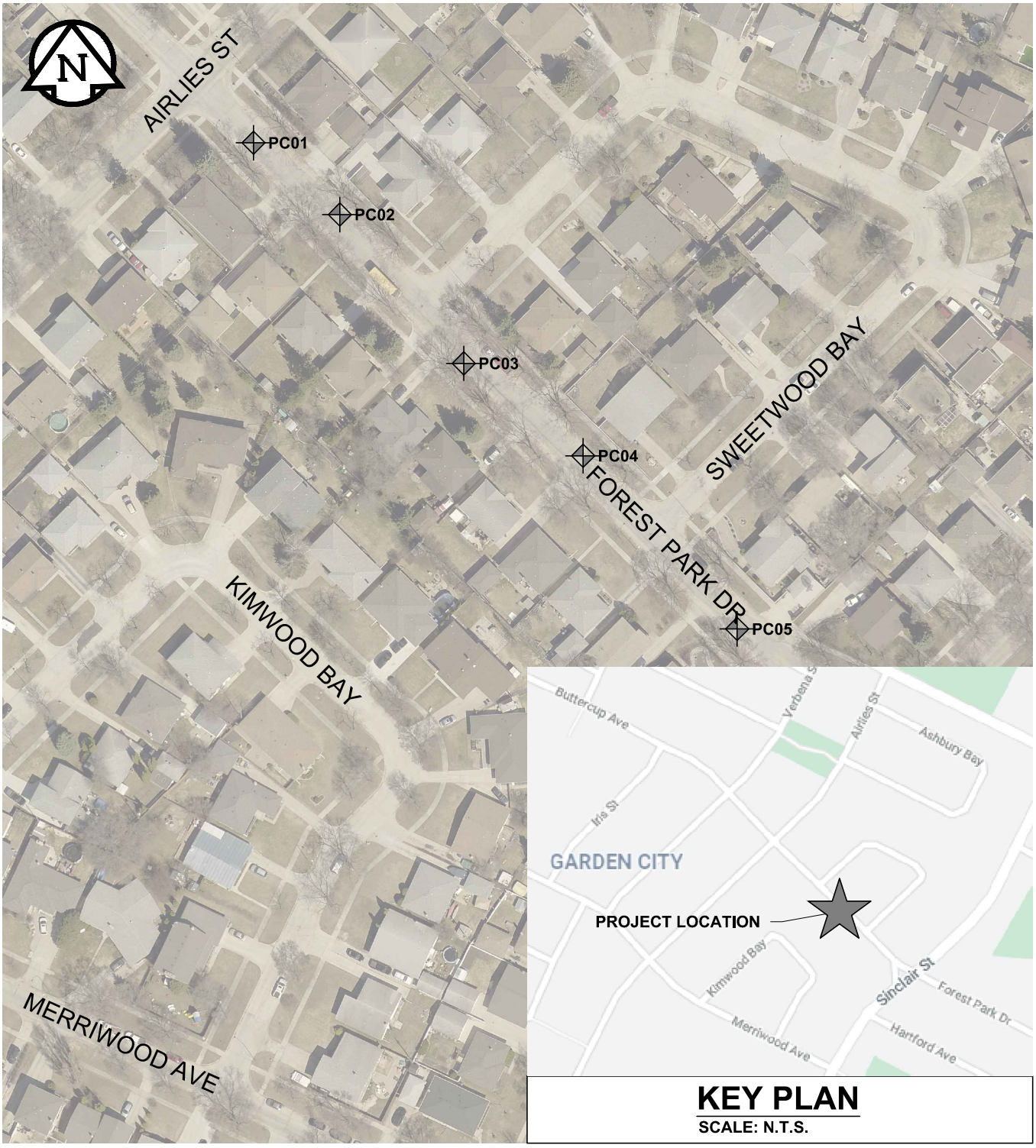
PAVEMENT CORE (TREK 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 10 20 30 40 50 m
SCALE = 1 : 1 250 (216 mm x 279 mm)

Figure 01
Pavement Core Location Plan



KEY PLAN
SCALE: N.T.S.

LEGEND:

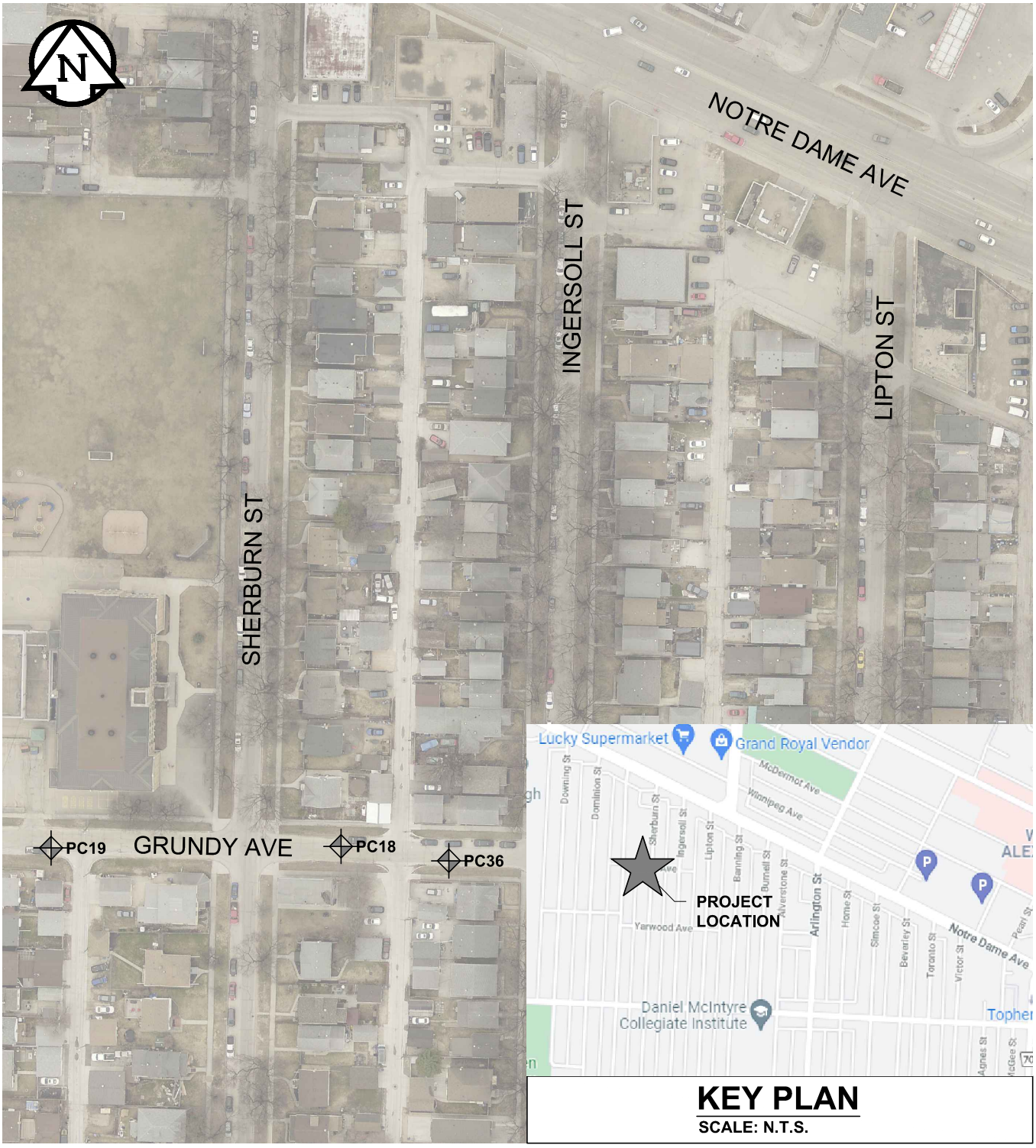
PAVEMENT CORE (TREK 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 25 50 75 m
SCALE = 1 : 1 500 (216 mm x 279 mm)

Figure 02
Pavement Core Location Plan



KEY PLAN
SCALE: N.T.S.

LEGEND:

PAVEMENT CORE (TREK 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 25 50 75 m
SCALE = 1 : 1 500 (216 mm x 279 mm)

Figure 03
Pavement Core Location Plan

KEY PLAN
SCALE: N.T.S.

LEGEND:

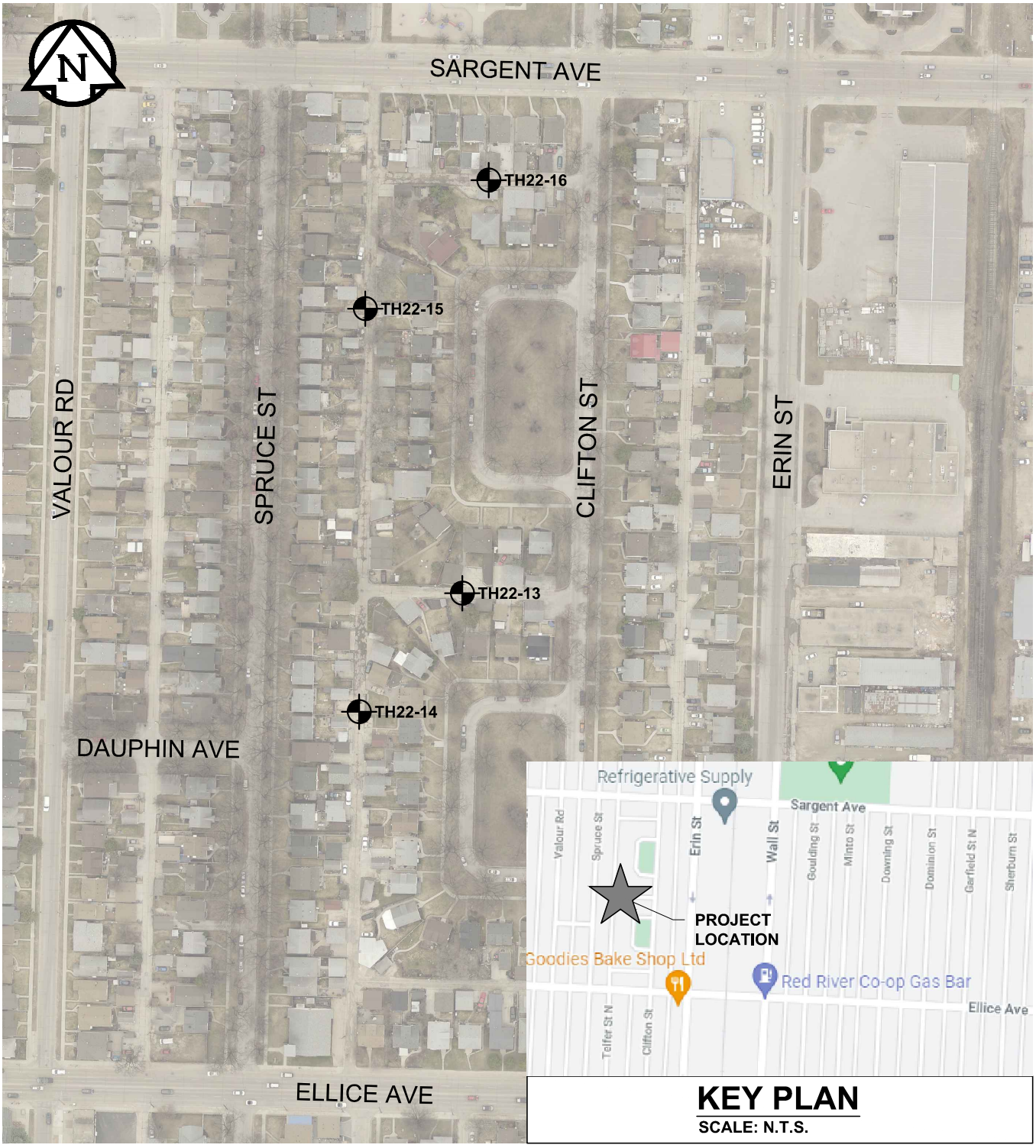
PAVEMENT CORE (TREK 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 25 50 75 100 m
SCALE = 1 : 2 000 (216 mm x 279 mm)

Figure 04
Pavement Core Location Plan



KEY PLAN
SCALE: N.T.S.

LEGEND:

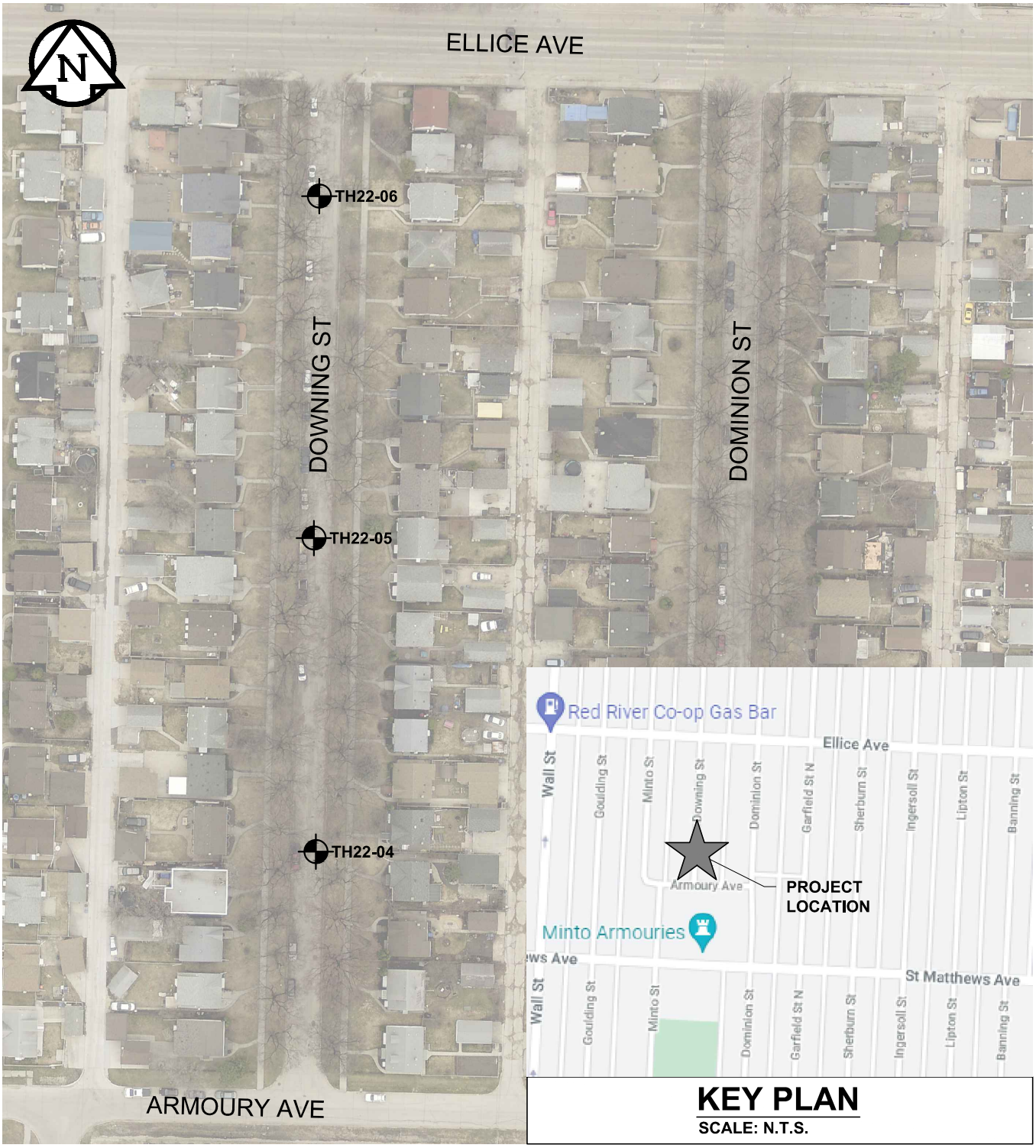
TEST HOLE (TREK, 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 25 50 75 100 m
SCALE = 1 : 2 250 (216 mm x 279 mm)

Figure 05
Test Hole Location Plan



KEY PLAN
SCALE: N.T.S.

LEGEND:

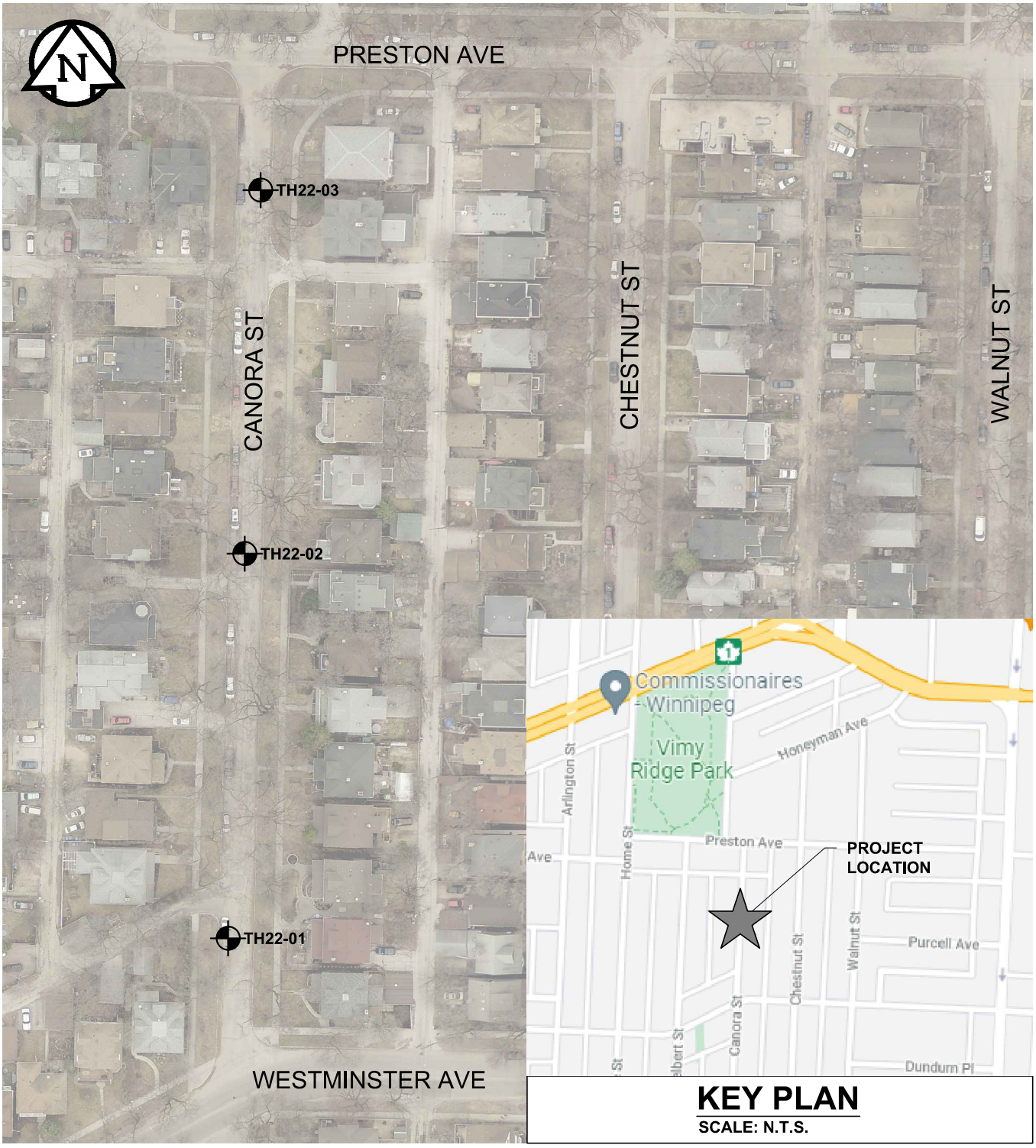
TEST HOLE (TREK, 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 10 20 30 40 50 m
SCALE = 1 : 1 250 (216 mm x 279 mm)

Figure 06
Test Hole Location Plan



KEY PLAN
SCALE: N.T.S.

LEGEND:

TEST HOLE (TREK, 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 10 20 30 40 50 m
SCALE = 1 : 1 250 (216 mm x 279 mm)

Figure 07
Test Hole Location Plan

TREK GEOTECHNICAL

1000 043 19
WSP
2022 Local Streets Package (22-R-05)

KEY PLAN
SCALE: N.T.S.

LEGEND:

TEST HOLE (TREK, 2022)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2016).

0 25 50 75 100 m
SCALE = 1 : 2 250 (216 mm x 279 mm)

Figure 08
Test Hole Location Plan

Appendix A

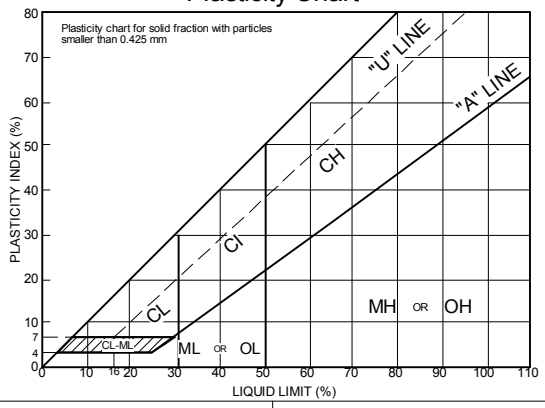
Test Hole Logs, Summary Table & Lab Testing Results and Pavement Core Photos – Canora Street

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent..... GW, GP, SW, SP; More than 12 percent..... GM, GC, SM, SC; 6 to 12 percent..... Borderline case4s requiring dual symbols*
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures	Not meeting all gradation requirements for GW
			GC		Clayey gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP		Poorly-graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL		Organic silts and organic silty clays of low plasticity	
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts	
			CH		Inorganic clays of high plasticity, fat clays	
			OH		Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit: Strong colour or odour, and often fibrous texture



Particle Size	Material	ASTM Sieve sizes	mm
	Sand		
	Coarse	#10 to #4	2.00 to 4.75
	Medium	#40 to #10	0.425 to 2.00
	Fine	#200 to #40	0.075 to 0.425
	Silt or Clay	< #200	< 0.075

Particle Size	Material	ASTM Sieve Sizes	mm
	Boulders	> 12 in.	> 300
	Cobbles	3 in. to 12 in.	75 to 300
	Gravel		
	Coarse	3/4 in. to 3 in.	19 to 75
	Fine	#4 to 3/4 in.	4.75 to 19

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH22-01
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5527163, E-631741 (Canora Street)
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - 100 mm thick		
		CONCRETE - 80 mm thick		PC22-20
		SAND (FILL) - gravelly (<20 mm diam.), some silt, trace clay - reddish brown - frozen to 1.5 m depth, dry to moist, compact to dense when thawed - poorly graded - rounded to sub-angular - AASHTO: A-1-b		G01
0.5				G02
1.0				G03
				G04
1.5		SILT and CLAY - trace sand - light brown, moist, firm to stiff, intermediate plasticity - AASHTO: A-7-6 (I)		G05
		CLAY - silty - brown - moist, stiff - high plasticity - AASHTO: A-7-6 (I)		G06
2.0				G07

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

END OF TEST HOLE AT 2.3 m IN CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #147 Canora st, Southbound lane, 1.5 m East of West curb.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-02
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5527237, E-631744 (Canora Street)
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
		ASPHALT - 100 mm thick				
		CONCRETE - 90 mm thick		PC22-21		
		CLAY - silty, trace sand, no to trace gravel (<10 mm diam.), trace organics - black - frozen to 1.5 m depth, moist and firm to stiff when thawed - high plasticity - AASHTO: A-7-6 (59)		G08		
0.5				G09		
1.0				G10		
		- grey, no organics and no gravel below 1.2 m		G11		
1.5		SILT and CLAY - trace sand - light brown, moist, firm, intermediate plasticity - AASHTO: A-7-6 (I)		G12		
		CLAY - silty, trace precipitates (supthate) - grey - moist, firm to stiff - high plasticity - AASHTO: A-7-6 (I)		G13		
2.0				G14		

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #169 Canora st, Southbound lane, 1.5 m East of West curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-03

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5527316, E-631747 (Canora Street)
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 70 mm thick				
		CONCRETE - 140 mm thick		PC22-22		
		CLAY - silty, trace sand, trace organics - black - frozen to 1.5 m depth, moist and firm to very stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G15	●	
0.5				G16	●	
1.0		- brown, no organics below 1.1 m		G17	●	△ ✤
				G18	●	△ ✤
1.5				G19	●	△ ✤
				G20	●	△ ✤
2.0		SILT and CLAY - light brown, moist, firm - intermediate plasticity - AASHTO: A-7-6 (I)		G21	●	✤

END OF TEST HOLE AT 2.3 m IN SILT and CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #189 Canora st, Northbound lane, 1.5 m West of East curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

2022 Local Street Package - 22-R-05
Sub-Surface Investigation
Canora Street : between Preston Avenue and Westminster Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH22-01	UTM : 14U 5527163 N, 631741 E Located in front of #147 Canora St., Southbound lane, 1.5 m East of West curb.	Asphalt	100	Concrete	80	Sand; AASHTO: A-1-b	0.3	0.5	7							
						Sand; AASHTO: A-1-b	0.6	0.8	6							
						Sand; AASHTO: A-1-b	0.9	1.1	5	17.0		56.0	27.0			
						Sand; AASHTO: A-1-b	1.2	1.4	6							
						Silt and Clay; AASHTO: A-7-6 (I)	1.5	1.7	39							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	41							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	45							
TH22-02	UTM : 14U 5527237 N, 631744 E Located in front of #169 Canora St., Southbound lane, 1.5 m East of West curb.	Asphalt	100	Concrete	90	Clay; AASHTO: A-7-6 (59)	0.3	0.5	26							
						Clay; AASHTO: A-7-6 (59)	0.6	0.8	33							
						Clay; AASHTO: A-7-6 (59)	0.9	1.1	34	64	26	9	1	21	80	59
						Clay; AASHTO: A-7-6 (59)	1.2	1.4	37							
						Silt and Clay; AASHTO: A-7-6 (I)	1.5	1.7	41							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	47							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	48							
TH22-03	UTM : 14U 5528209 N, 630791 E Located in front of #189 Canora St., Northbound lane, 1.5 m West of East curb.	Asphalt	70	Concrete	140	Clay; AASHTO: A-7-6 (I)	0.3	0.5	27							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	27							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	27							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	29							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	33							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	41							
						Silt and Clay; AASHTO: A-7-6 (I)	2.1	2.3	36							

(I) - AASHTO classification was interpreted based on visual classification.

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05-Canora Street

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0
Sample #	G01	G02	G03	G04	G05	G06
Tare ID	F58	E35	FUPA	A106	K20	P08
Mass of tare	8.7	8.5	232.2	8.3	8.6	8.6
Mass wet + tare	198.1	214.1	1258.3	257.2	290.2	254.7
Mass dry + tare	185.4	203.2	1211.1	244.2	210.7	182.9
Mass water	12.7	10.9	47.2	13.0	79.5	71.8
Mass dry soil	176.7	194.7	978.9	235.9	202.1	174.3
Moisture %	7.2%	5.6%	4.8%	5.5%	39.3%	41.2%

Test Hole	TH22-01	TH22-02	TH22-02	TH22-02	TH22-02	TH22-02
Depth (m)	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7
Sample #	G07	G08	G09	G10	G11	G12
Tare ID	W48	Z114	Z93	K28	W07	D45
Mass of tare	8.4	8.3	8.5	8.5	8.4	8.5
Mass wet + tare	174.8	251.9	230.5	413.1	165.3	237.1
Mass dry + tare	123.5	201.7	175.1	310.3	123.2	171.0
Mass water	51.3	50.2	55.4	102.8	42.1	66.1
Mass dry soil	115.1	193.4	166.6	301.8	114.8	162.5
Moisture %	44.6%	26.0%	33.3%	34.1%	36.7%	40.7%

Test Hole	TH22-02	TH22-02	TH22-03	TH22-03	TH22-03	TH22-03
Depth (m)	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4
Sample #	G13	G14	G15	G16	G17	G18
Tare ID	N113	F16	D5	D50	AB84	E106
Mass of tare	8.6	8.4	8.2	8.4	6.5	8.5
Mass wet + tare	154.4	229.8	208.2	182.8	195.5	205.7
Mass dry + tare	107.6	157.6	165.6	146.1	155.0	162.0
Mass water	46.8	72.2	42.6	36.7	40.5	43.7
Mass dry soil	99.0	149.2	157.4	137.7	148.5	153.5
Moisture %	47.3%	48.4%	27.1%	26.7%	27.3%	28.5%

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05-Canora Street

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-03	TH22-03	TH22-03			
Depth (m)	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3			
Sample #	G19	G20	G21			
Tare ID	AB51	E87	E22			
Mass of tare	6.6	8.5	8.7			
Mass wet + tare	262.1	237.7	262.0			
Mass dry + tare	198.4	171.2	194.8			
Mass water	63.7	66.5	67.2			
Mass dry soil	191.8	162.7	186.1			
Moisture %	33.2%	40.9%	36.1%			

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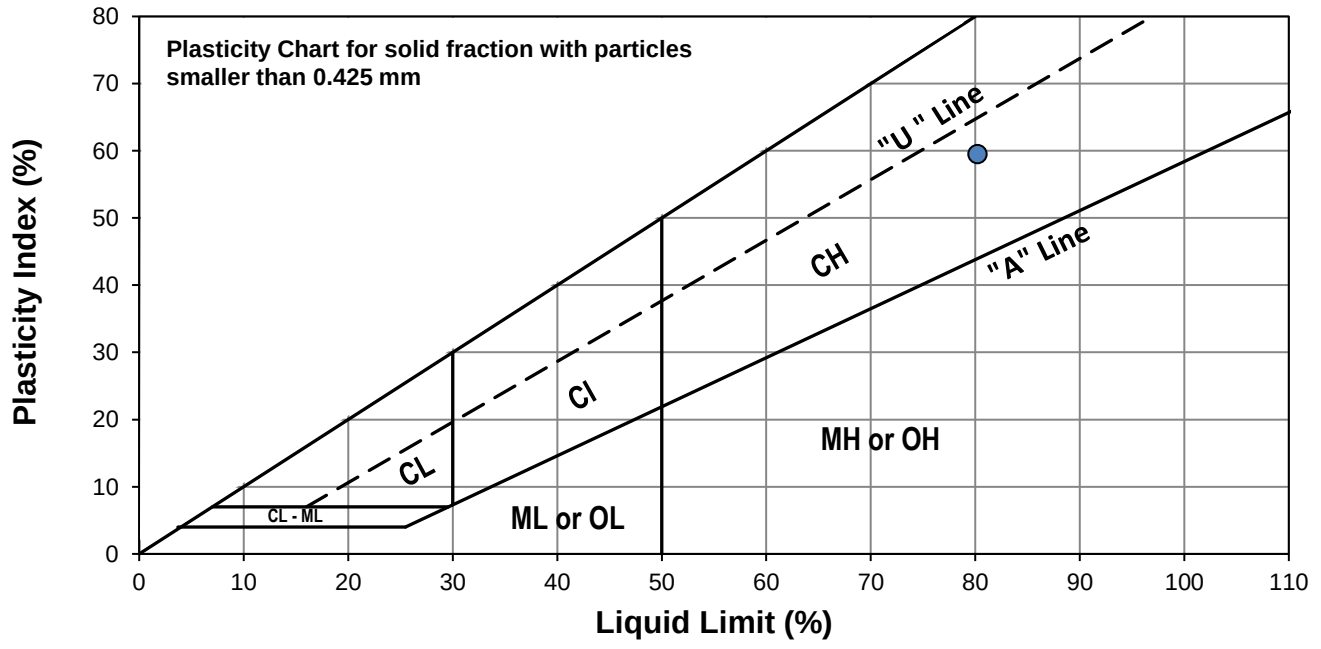
Atterberg Limits
ASTM D4318-10e1

Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05 - Canora Street
Test Hole	TH22-02
Sample #	G10
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	11-Feb-22
Technician	AD

Liquid Limit	80
Plastic Limit	21
Plasticity Index	59

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	27	33		
Mass Tare (g)	14.114	14.084	14.056		
Mass Wet Soil + Tare (g)	23.356	24.408	23.119		
Mass Dry Soil + Tare (g)	19.129	19.835	19.147		
Mass Water (g)	4.227	4.573	3.972		
Mass Dry Soil (g)	5.015	5.751	5.091		
Moisture Content (%)	84.287	79.517	78.020		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.177	14.114			
Mass Wet Soil + Tare (g)	21.322	21.370			
Mass Dry Soil + Tare (g)	20.096	20.127			
Mass Water (g)	1.226	1.243			
Mass Dry Soil (g)	5.919	6.013			
Moisture Content (%)	20.713	20.672			

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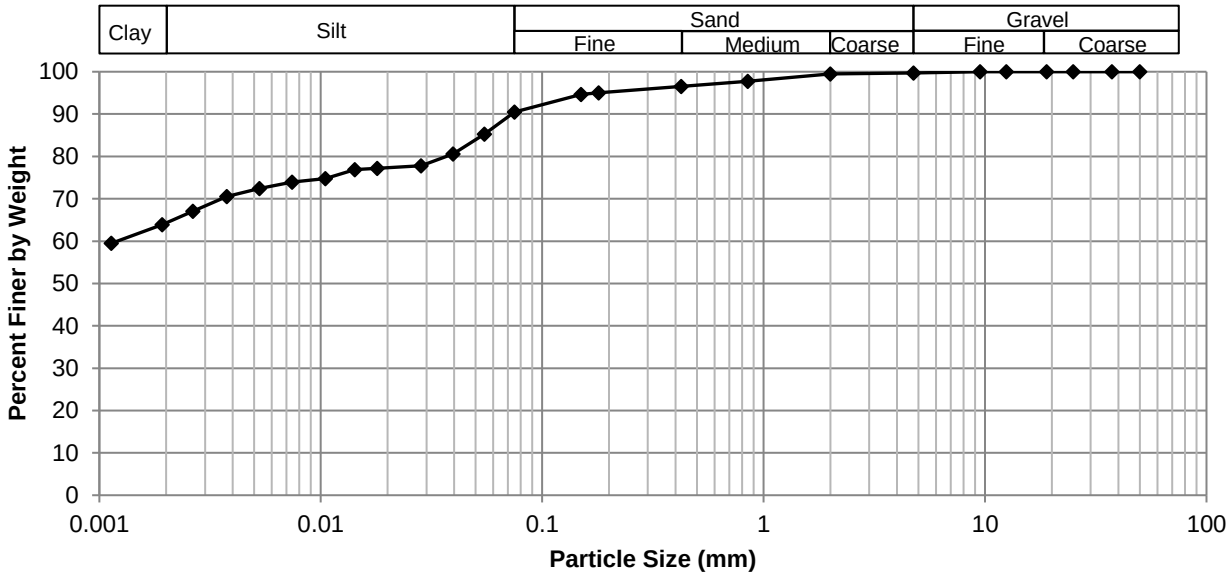
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05-Canora Street
Test Hole	TH22-02
Sample #	G10
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.3%
Sand	9.3%
Silt	26.3%
Clay	64.2%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	99.74	0.0750	90.47
37.5	100.00	2.00	99.49	0.0548	85.29
25.0	100.00	0.850	97.78	0.0396	80.62
19.0	100.00	0.425	96.52	0.0284	77.82
12.5	100.00	0.180	95.02	0.0180	77.20
9.50	100.00	0.150	94.67	0.0142	76.89
4.75	99.74	0.075	90.47	0.0105	74.77
				0.0074	73.90
				0.0053	72.41
				0.0038	70.55
				0.0026	67.06
				0.0019	63.90
				0.0011	59.48

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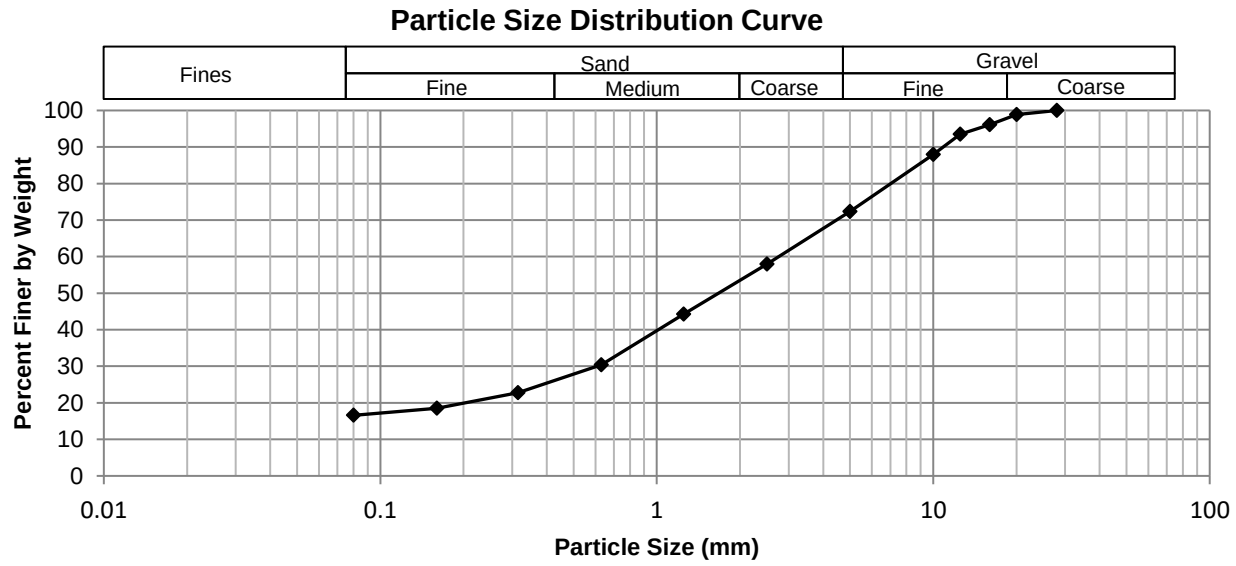
Grain Size Analysis (Sieve Method)
ASTM C136-06

Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05 - Canora Street
Test Hole	TH22-01
Sample #	G03
Depth (m)	0.9-1.1
Date Sampled	7-Feb-22
Date Tested	10-Feb-22
Technician	NM

Total Weight (g)	978.0
Gravel %	27.6
Sand %	55.8
Fines %	16.6



Sieve Opening (mm)	Percent Passing	Specification (Min-Max)
28.0	100	-
20.0	99	-
16.0	96	-
12.5	93	-
10.0	88	-
5.0	72	-
2.50	58	-
1.25	44	-
0.630	30	-
0.315	23	-
0.160	19	-
0.080	17	-

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Standard Proctor Compaction Test

ASTM D698-12e2

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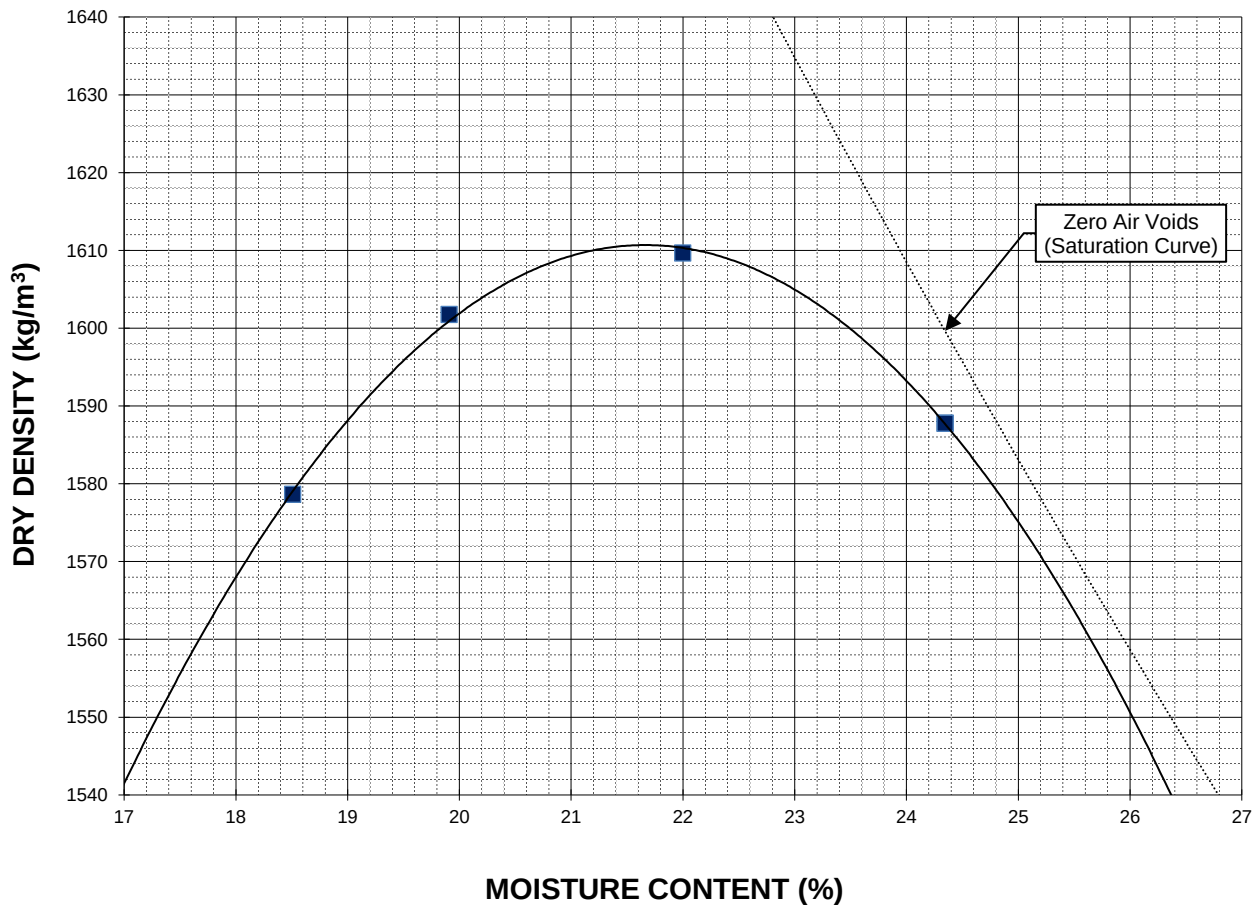
Project No.	1000-043-19
Client	WSP
Project	2022 Local Streets Package
Sample #	Combined bulk samples
Source	TH22-02, 03
Material	Clay
Sample Date	07-Feb-22
Test Date	10-Feb-22
Technician	RS

Maximum Dry Density (kg/m3)	1611
Optimum Moisture (%)	21.7

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1871	1921	1964	1974	
Dry Density (kg/m^3)	1579	1602	1610	1588	
Moisture Content (%)	18.5	19.9	22.0	24.3	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-02, 03
Client	WSP	**Material**	Clay
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Canora St)	**Test Date**	2022-02-11
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1611	kg/m3
Optimum Moisture Content	21.7	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1528	kg/m3
Initial Moisture Content	22.7	%
Relative Density	94.8	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.5	%
Moisture Content in top 25 mm	26.6	%
Immersion Period	96	h

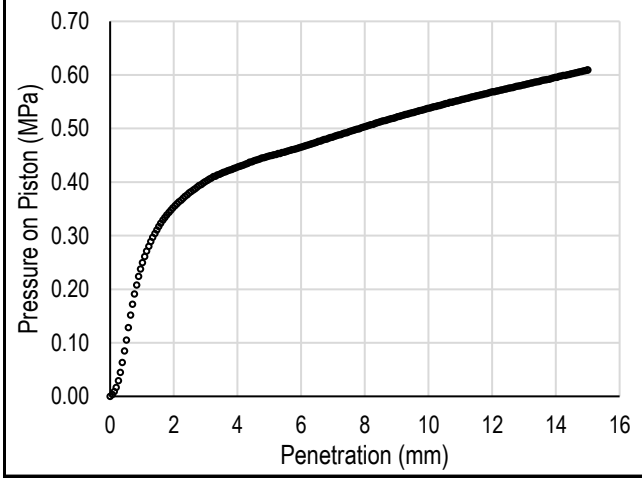
CBR Results

CBR at 2.54 mm	5.5	%
CBR at 5.08 mm	4.4	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.15	0.15
1.27	0.29	0.29
1.91	0.35	0.35
2.54	0.38	0.38
3.18	0.41	0.41
3.81	0.42	0.42
4.45	0.44	0.44
5.08	0.45	0.45
7.62	0.50	0.50
10.16	0.54	0.54
12.70	0.58	0.58

Load/Penetration Curve



Comments:

Photo 1: Pavement Core Sample at Test Hole TH22-01

Photo 2: Pavement Core Sample at Test Hole TH22-02

Photo 3: Pavement Core Sample at Test Hole TH22-03

Appendix B

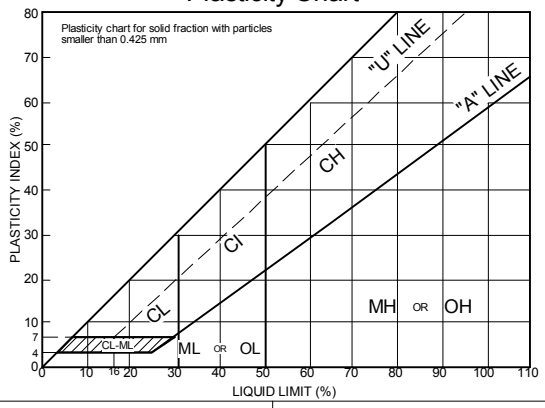
Test Hole Logs, Summary Table & Lab Testing Results and Pavement Core Photos – Downing Street

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent..... GW, GP, SW, SP; More than 12 percent..... GM, GC, SM, SC; 6 to 12 percent..... Borderline case4s requiring dual symbols*
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures	Not meeting all gradation requirements for GW
			GC		Clayey gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP		Poorly-graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL		Organic silts and organic silty clays of low plasticity	
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts	
			CH		Inorganic clays of high plasticity, fat clays	
			OH		Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit: Strong colour or odour, and often fibrous texture



Particle Size	Material	ASTM Sieve sizes	mm
	Sand		
	Coarse	#10 to #4	2.00 to 4.75
	Medium	#40 to #10	0.425 to 2.00
	Fine	#200 to #40	0.075 to 0.425
	Silt or Clay	< #200	< 0.075

Particle Size	Material	ASTM Sieve Sizes	mm
	Boulders	> 12 in.	> 300
	Cobbles	3 in. to 12 in.	75 to 300
	Gravel		
	Coarse	3/4 in. to 3 in.	19 to 75
	Fine	#4 to 3/4 in.	4.75 to 19

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH22-04
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528209, E-630791 (Downing Street)
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 7, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
		CONCRETE - 180 mm thick		PC22-23		
		CLAY - silty, trace sand, trace organics - black, - frozen to 1.5 m depth, moist and stiff to very stiff when thawed - high plasticity - AASHTO: A-7-6 (50)		G22		
0.5		- brown, no organics below 0.6 m		G23		
1.0				G24		
				G25		
1.5		SILT - some clay, trace sand - light brown - moist, soft - low plasticity - AASHTO: A-4 (I)		G26		
				G27		
2.0				G28		

END OF TEST HOLE AT 2.3 m IN SILT
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #821 Downing st, Northbound Lane, 1.5 m West of East curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-05
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528278, E-630790 (Downing Street)
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 7, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 45 mm thick				
		CONCRETE - 175 mm thick		PC22-24		
		CLAY - silty, trace sand, trace organics - black - frozen, moist and firm when thawed - high plasticity - AASHTO: A-7-6 (I)		G29		
0.5				G30		
		- light brown, no organics below 0.9 m		G31		
1.0		SILT - some clay, trace sand - light brown - frozen to 1.5 m depth, moist and soft when thawed - low to intermediate plasticity - AASHTO: A-4 (I)		G32		
1.5		CLAY - silty - brown - moist, stiff to very stiff - high plasticity - AASHTO: A-7-6 (I)		G33		
				G34		
2.0				G35		

END OF TEST HOLE AT 2.3 m IN CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #857 Downing st, Southbound lane, 1.5 m East of West curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-06

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528352, E-630795 (Downing Street)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 7, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 20 mm thick				
		CONCRETE - 190 mm thick		PC22-25		
		CLAY - silty, trace organics - black, frozen, moist and firm when thawed, high plasticity - AASHTO: A-7-6 (I)		G36	●	
0.5		SILT - some clay, trace sand - light brown - frozen, moist and soft when thawed - low plasticity - AASHTO: A-4 (3)		G37	●	
				G38	●	
1.0		CLAY - silty - brown - frozen to 1.5 m depth, moist and firm to stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G39	●	△✤
1.5				G40	●	△✤
				G41	●	△✤
2.0				G42	●	✤

END OF TEST HOLE AT 2.3 m IN CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #889 Downing st, Northbound lane, 1.5 m West of East curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

2022 Local Street Package - 22-R-05
Sub-Surface Investigation
Downing Street- between Ellice Avenue and Armoury Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH22-04	UTM : 14U 5528209 N, 630791 E Located in front of #821 Downing St., Northbound lane, 1.5 m West of East curb.	Asphalt	-	Concrete	180	Clay; AASHTO: A-7-6 (50)	0.3	0.5	25							
						Clay; AASHTO: A-7-6 (50)	0.6	0.8	27							
						Clay; AASHTO: A-7-6 (50)	0.9	1.1	28	56	43	1	0	19	64	45
						Clay; AASHTO: A-7-6 (50)	1.2	1.4	29							
						Silt; AASHTO: A-4 (I)	1.5	1.7	23							
						Silt; AASHTO: A-4 (I)	1.8	2.0	23							
						Silt; AASHTO: A-4 (I)	2.1	2.3	22							
TH22-05	UTM : 14U 5528278 N, 630790 E Located in front of #857 Downing St., Southbound lane, 1.5 m East of West curb.	Asphalt	45	Concrete	175	Clay; AASHTO: A-7-6 (I)	0.3	0.5	36							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	33							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	31							
						Silt; AASHTO: A-4 (I)	1.2	1.4	23							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	36							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	39							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	45							
TH22-06	UTM : 14U 5528352 N, 630790 E Located in front of #889 Downing St., Northbound lane, 1.5 m West of East curb.	Asphalt	20	Concrete	190	Clay; AASHTO: A-7-6 (I)	0.3	0.5	33							
						Silt; AASHTO: A-4 (3)	0.6	0.8	30							
						Silt; AASHTO: A-4 (3)	0.9	1.1	23	14	81	5	0	18	23	5
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	33							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	38							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	41							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	52							

(I) - AASHTO classification was interpreted based on visual classification.

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05- Downing Street

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-04	TH22-04	TH22-04	TH22-04	TH22-04	TH22-04
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0
Sample #	G22	G23	G24	G25	G26	G27
Tare ID	Z36	Z13	W35	W10	H16	Z22
Mass of tare	8.3	8.6	8.2	8.4	8.4	8.3
Mass wet + tare	292.7	288.4	414.4	283.1	262.2	240.6
Mass dry + tare	236.2	229.7	326.8	221.8	214.0	198.0
Mass water	56.5	58.7	87.6	61.3	48.2	42.6
Mass dry soil	227.9	221.1	318.6	213.4	205.6	189.7
Moisture %	24.8%	26.5%	27.5%	28.7%	23.4%	22.5%

Test Hole	TH22-04	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05
Depth (m)	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7
Sample #	G28	G29	G30	G31	G32	G33
Tare ID	Z47	F100	W26	N35	Z85	N54
Mass of tare	8.5	8.3	8.2	8.4	8.3	8.5
Mass wet + tare	199.1	339.8	255.1	386.2	235.9	357.2
Mass dry + tare	164.5	252.9	193.8	297.4	193.1	264.6
Mass water	34.6	86.9	61.3	88.8	42.8	92.6
Mass dry soil	156.0	244.6	185.6	289.0	184.8	256.1
Moisture %	22.2%	35.5%	33.0%	30.7%	23.2%	36.2%

Test Hole	TH22-05	TH22-05	TH22-06	TH22-06	TH22-06	TH22-05
Depth (m)	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4
Sample #	G34	G35	G36	G37	G38	G39
Tare ID	N22	N75	N02	AB78	Z78	H66
Mass of tare	8.5	8.5	8.6	6.6	8.4	8.3
Mass wet + tare	241.3	235.0	244.2	203.2	473.2	211.5
Mass dry + tare	176.6	165.1	185.3	158.3	385.5	161.4
Mass water	64.7	69.9	58.9	44.9	87.7	50.1
Mass dry soil	168.1	156.6	176.7	151.7	377.1	153.1
Moisture %	38.5%	44.6%	33.3%	29.6%	23.3%	32.7%

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05- Downing Street

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-06	TH22-05	TH22-06			
Depth (m)	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3			
Sample #	G40	G41	G42			
Tare ID	N41	H80	Z39			
Mass of tare	8.4	8.6	8.4			
Mass wet + tare	270.6	225.9	220.2			
Mass dry + tare	198.4	162.6	147.8			
Mass water	72.2	63.3	72.4			
Mass dry soil	190.0	154.0	139.4			
Moisture %	38.0%	41.1%	51.9%			

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Atterberg Limits
ASTM D4318-10e1

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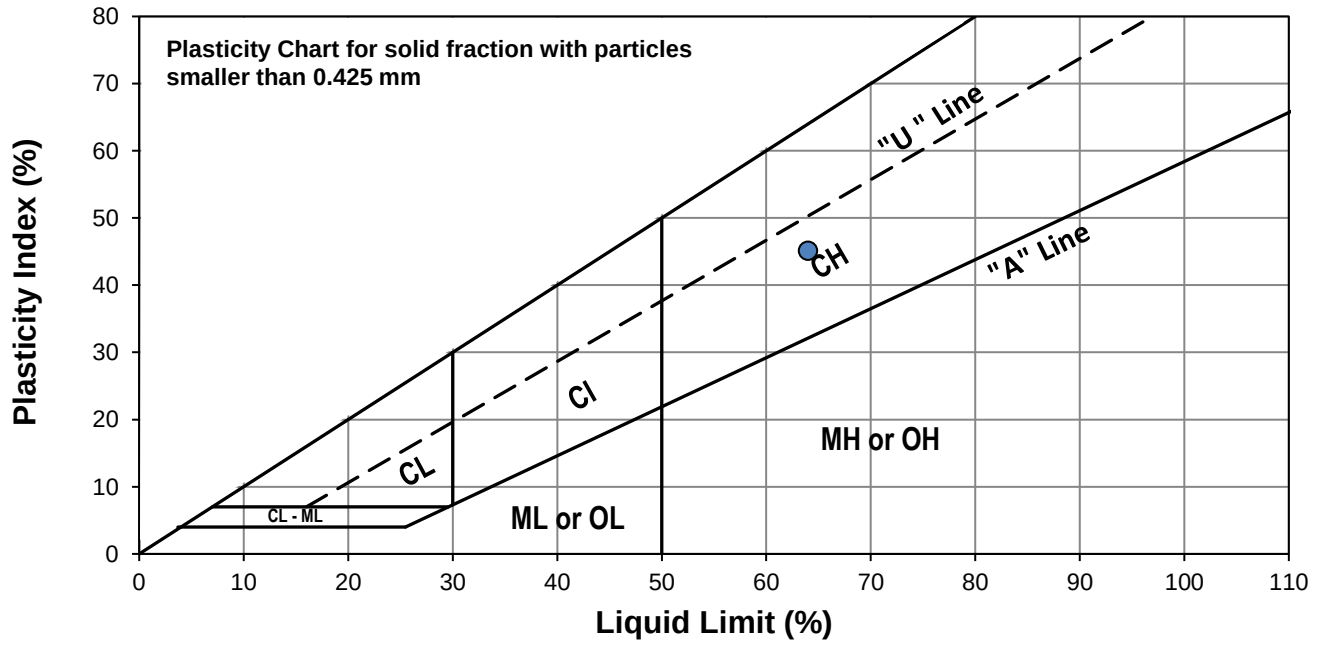
Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05-Downing Street
Test Hole	TH22-04
Sample #	G24
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	11-Feb-22
Technician	AD

Liquid Limit	64
Plastic Limit	19
Plasticity Index	45

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	29	34		
Mass Tare (g)	13.864	14.025	14.061		
Mass Wet Soil + Tare (g)	24.972	25.696	24.821		
Mass Dry Soil + Tare (g)	20.560	21.169	20.706		
Mass Water (g)	4.412	4.527	4.115		
Mass Dry Soil (g)	6.696	7.144	6.645		
Moisture Content (%)	65.890	63.368	61.926		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.107	14.062			
Mass Wet Soil + Tare (g)	20.358	21.513			
Mass Dry Soil + Tare (g)	19.359	20.340			
Mass Water (g)	0.999	1.173			
Mass Dry Soil (g)	5.252	6.278			
Moisture Content (%)	19.021	18.684			

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Atterberg Limits
ASTM D4318-10e1

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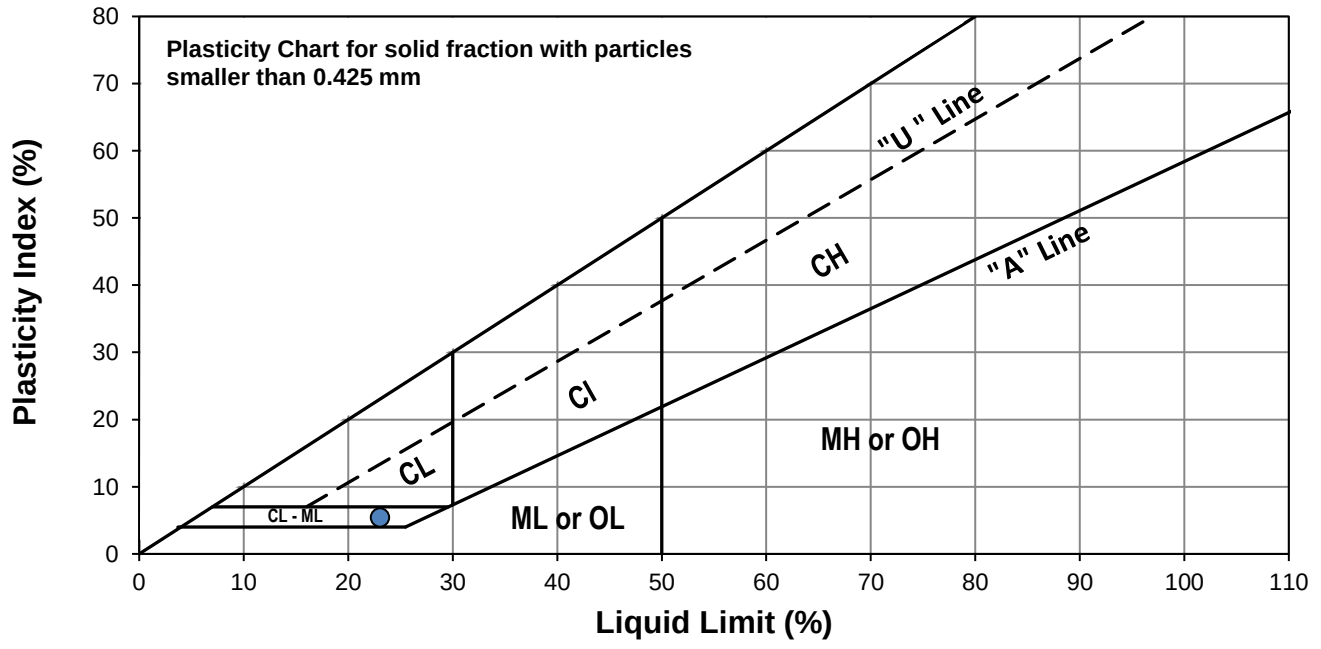
Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05-Downing Street
Test Hole	TH22-06
Sample #	G38
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	11-Feb-22
Technician	AD

Liquid Limit	23
Plastic Limit	18
Plasticity Index	5

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	19	25	33		
Mass Tare (g)	14.174	13.919	14.183		
Mass Wet Soil + Tare (g)	26.352	24.563	31.100		
Mass Dry Soil + Tare (g)	23.970	22.577	28.066		
Mass Water (g)	2.382	1.986	3.034		
Mass Dry Soil (g)	9.796	8.658	13.883		
Moisture Content (%)	24.316	22.938	21.854		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	13.937	14.153			
Mass Wet Soil + Tare (g)	22.145	23.572			
Mass Dry Soil + Tare (g)	20.925	22.150			
Mass Water (g)	1.220	1.422			
Mass Dry Soil (g)	6.988	7.997			
Moisture Content (%)	17.459	17.782			

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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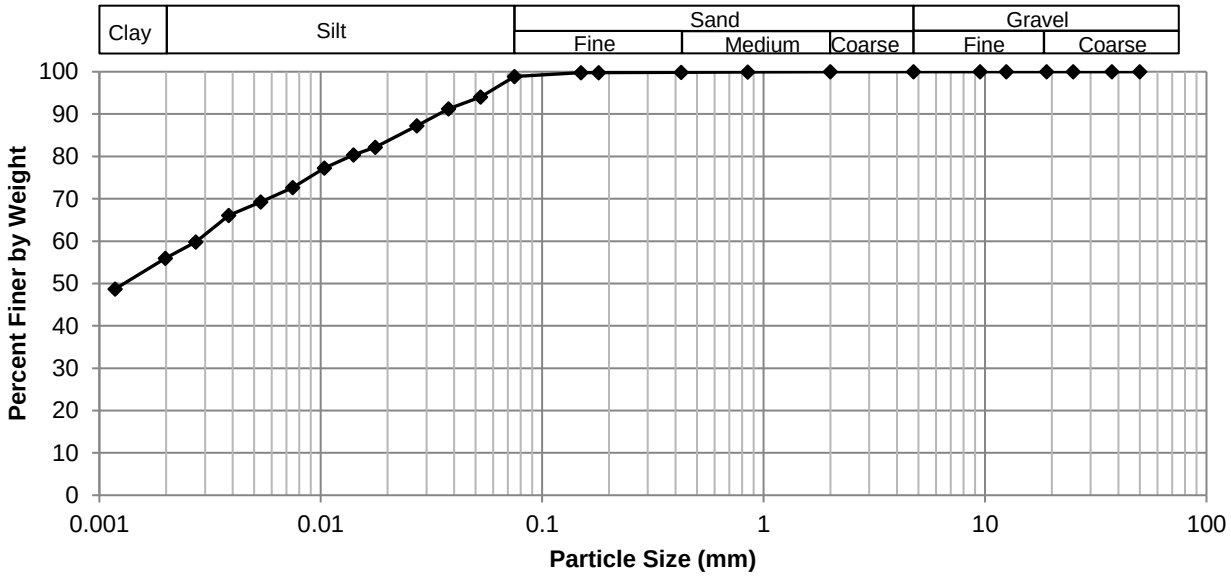
Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05-Downing Street
Test Hole	TH22-04
Sample #	G24
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.0%
Sand	1.2%
Silt	42.8%
Clay	56.0%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	98.84
37.5	100.00	2.00	100.00	0.0527	94.03
25.0	100.00	0.850	99.92	0.0378	91.27
19.0	100.00	0.425	99.88	0.0272	87.21
12.5	100.00	0.180	99.79	0.0176	82.21
9.50	100.00	0.150	99.75	0.0141	80.33
4.75	100.00	0.075	98.84	0.0104	77.26
				0.0075	72.62
				0.0054	69.24
				0.0038	66.11
				0.0027	59.80
				0.0020	55.96
				0.0012	48.71

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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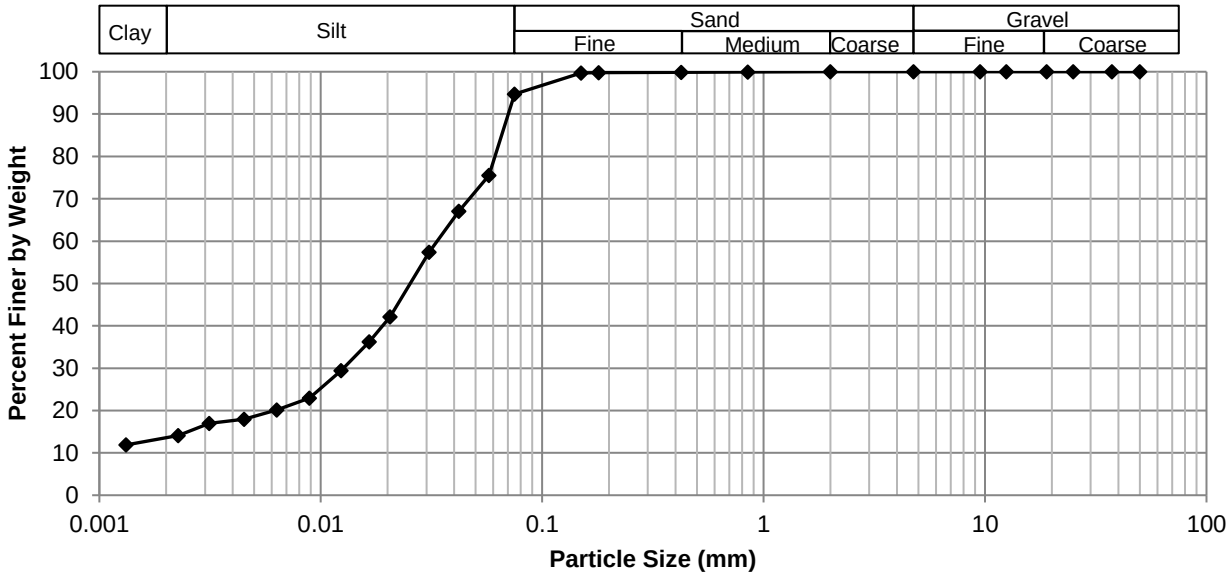
Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05-Downing Street
Test Hole	TH22-06
Sample #	G38
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.0%
Sand	5.3%
Silt	81.3%
Clay	13.4%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	94.71
37.5	100.00	2.00	99.99	0.0575	75.52
25.0	100.00	0.850	99.91	0.0421	67.08
19.0	100.00	0.425	99.86	0.0309	57.39
12.5	100.00	0.180	99.75	0.0206	42.15
9.50	100.00	0.150	99.71	0.0166	36.21
4.75	100.00	0.075	94.71	0.0124	29.40
				0.0089	22.91
				0.0063	20.17
				0.0045	17.98
				0.0031	16.97
				0.0023	14.07
				0.0013	11.88

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Standard Proctor Compaction Test

ASTM D698-12e2

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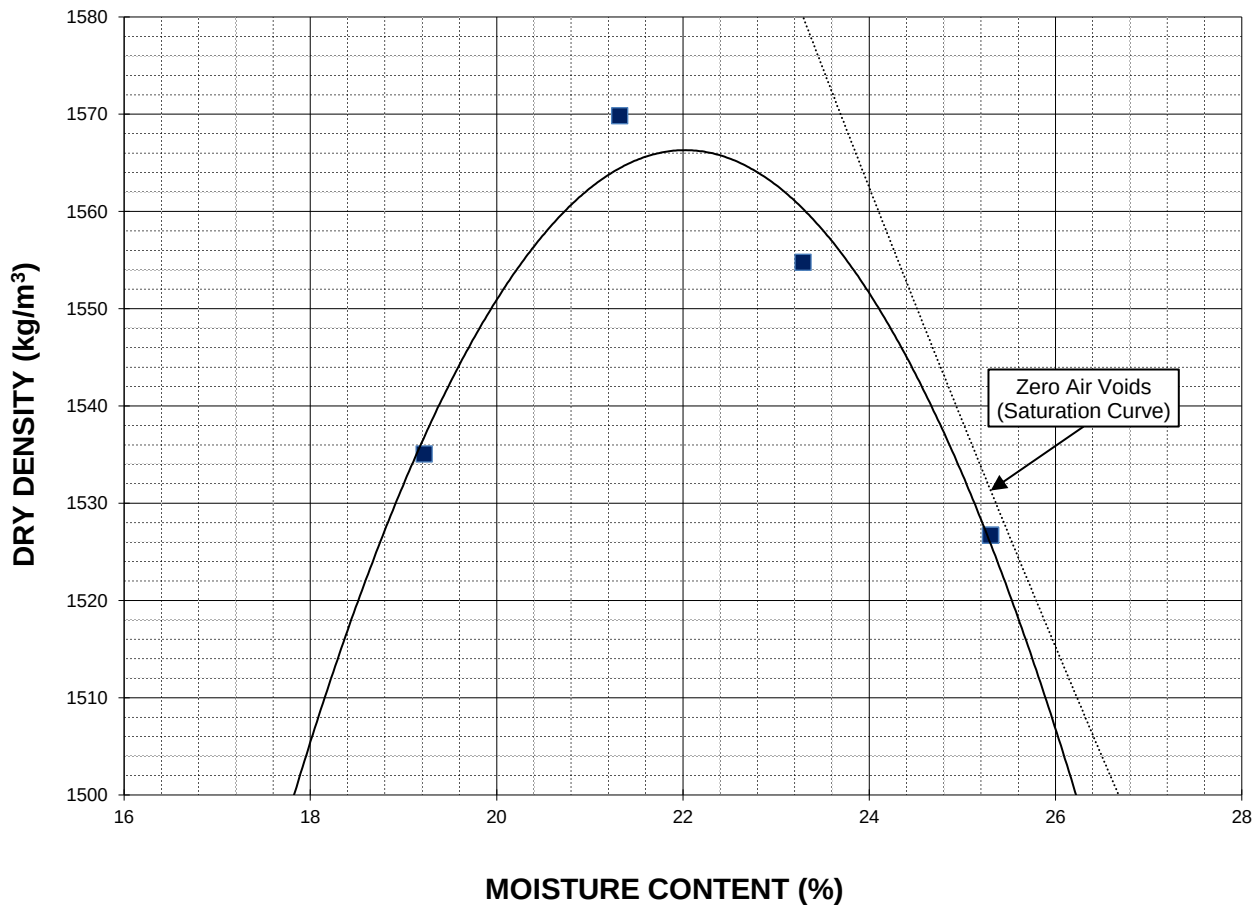
Project No.	1000-043-19
Client	WSP
Project	2022 Local Streets Package
Sample #	Combined bulk samples
Source	TH22-04, 05, 06 (Downing St.)
Material	Clay
Sample Date	07-Feb-22
Test Date	10-Feb-22
Technician	RS

Maximum Dry Density (kg/m3)	1566
Optimum Moisture (%)	22.0

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1830	1905	1917	1913	
Dry Density (kg/m^3)	1535	1570	1555	1527	
Moisture Content (%)	19.2	21.3	23.3	25.3	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-04,05,06
Client	WSP	**Material**	Clay
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Downing Street)	**Test Date**	2022-02-16
		Technician	RS

Proctor Results (ASTM D698)

Maximum Dry Density	1566	kg/m3
Optimum Moisture Content	22.0	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1478	kg/m3
Initial Moisture Content	23.5	%
Relative Density	94.4	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	1.3	%
Moisture Content in top 25 mm	35.2	%
Immersion Period	96	h

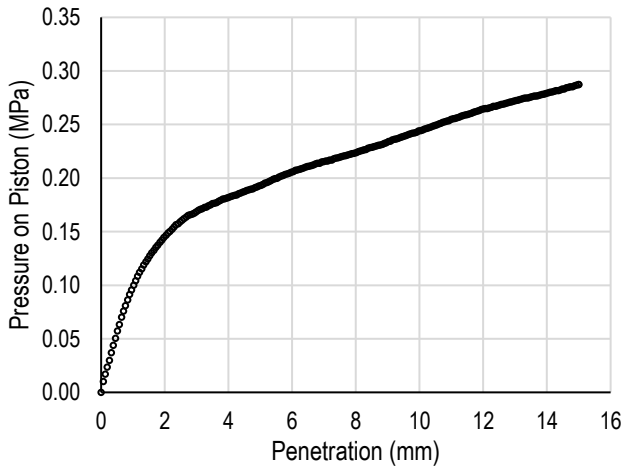
CBR Results

CBR at 2.54 mm	2.3	%
CBR at 5.08 mm	1.9	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.07	0.07
1.27	0.12	0.12
1.91	0.14	0.14
2.54	0.16	0.16
3.18	0.17	0.17
3.81	0.18	0.18
4.45	0.19	0.19
5.08	0.19	0.19
7.62	0.22	0.22
10.16	0.25	0.25
12.70	0.27	0.27

Load/Penetration Curve



Comments:

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Standard Proctor Compaction Test

ASTM D698-12e2

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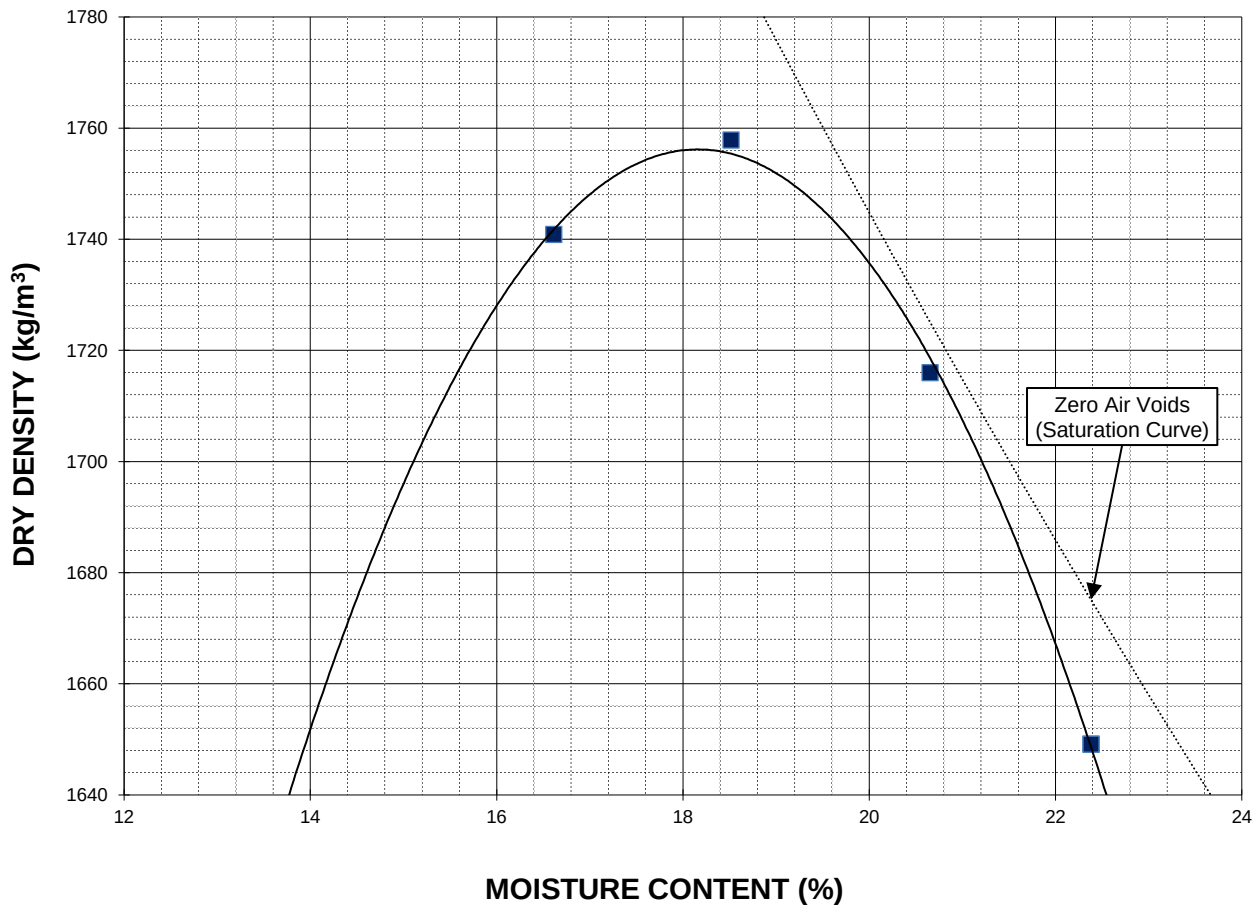
Project No.	1000-043-19
Client	WSP
Project	2022 Local Streets Package
Sample #	Combined bulk samples
Source	TH22-05, 06 (Downing St.)
Material	Silt
Sample Date	07-Feb-22
Test Date	10-Feb-22
Technician	RS

Maximum Dry Density (kg/m3)	1756
Optimum Moisture (%)	18.2

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	2030	2083	2070	2018	
Dry Density (kg/m^3)	1741	1758	1716	1649	
Moisture Content (%)	16.6	18.5	20.7	22.4	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-05,06
Client	WSP	**Material**	Silt
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Downing Street)	**Test Date**	2022-02-16
		Technician	RS

Proctor Results (ASTM D698)

Maximum Dry Density	1756	kg/m3
Optimum Moisture Content	18.2	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1662	kg/m3
Initial Moisture Content	20.1	%
Relative Density	94.7	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.3	%
Moisture Content in top 25 mm	25.0	%
Immersion Period	96	h

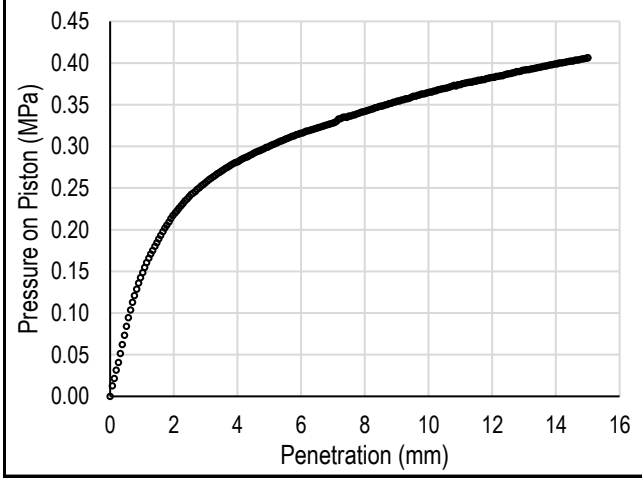
CBR Results

CBR at 2.54 mm	3.5	%
CBR at 5.08 mm	2.9	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.10	0.10
1.27	0.17	0.17
1.91	0.21	0.21
2.54	0.24	0.24
3.18	0.26	0.26
3.81	0.28	0.28
4.45	0.29	0.29
5.08	0.30	0.30
7.62	0.34	0.34
10.16	0.37	0.37
12.70	0.39	0.39

Load/Penetration Curve



Comments:

Photo 1: Pavement Core Sample at Test Hole TH22-04

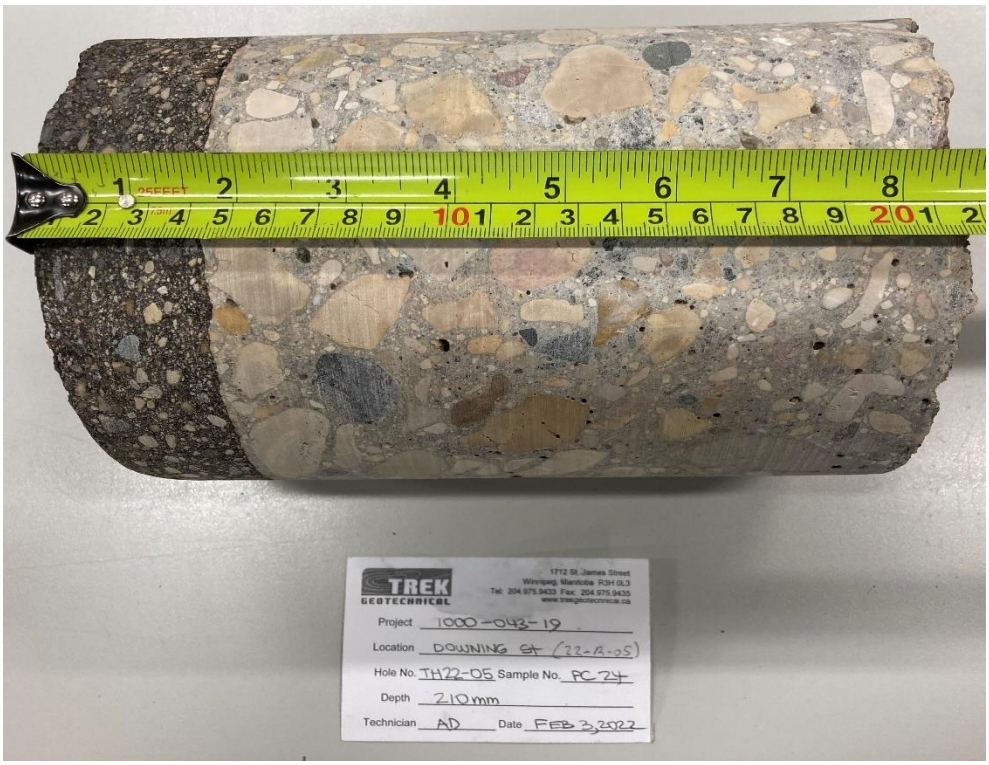


Photo 02: Pavement Core Sample at Test Hole TH22-05

Photo 3: Pavement Core Sample at Test Hole TH22-06

Appendix C

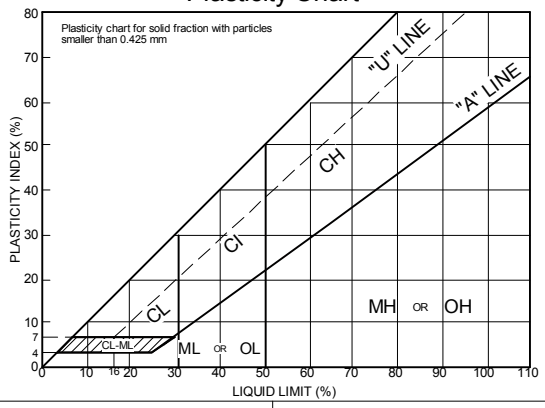
Test Hole Logs, Summary Table & Lab Testing Results and Pavement Core Photos – Palmerston Avenue

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent..... GW, GP, SW, SP; More than 12 percent..... GM, GC, SM, SC; 6 to 12 percent..... Borderline case4s requiring dual symbols*
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures	Not meeting all gradation requirements for GW
			GC		Clayey gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP		Poorly-graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL		Organic silts and organic silty clays of low plasticity	
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts	
			CH		Inorganic clays of high plasticity, fat clays	
			OH		Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit: Strong colour or odour, and often fibrous texture



Particle Size	Material	ASTM Sieve sizes	mm
	Sand		
	Coarse	#10 to #4	2.00 to 4.75
	Medium	#40 to #10	0.425 to 2.00
	Fine	#200 to #40	0.075 to 0.425
	Silt or Clay	< #200	< 0.075

Particle Size	Material	ASTM Sieve Sizes	mm
	Boulders	> 12 in.	> 300
	Cobbles	3 in. to 12 in.	75 to 300
	Gravel		
	Coarse	3/4 in. to 3 in.	19 to 75
	Fine	#4 to 3/4 in.	4.75 to 19

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH22-07
1 of 1

TREK GEOTECHNICAL

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5526586, E-631325 (Palmerston Avenue)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21	Particle Size (%) 0 20 40 60 80 100	PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 30 mm thick						
		CONCRETE - 210 mm thick		PC22-26				
		CLAY - silty, trace sand - brown - frozen to 1.8 m depth, moist and stiff to very stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G43				
0.5				G44				
				G45				
1.0				G46				
				G47				
1.5				G48				
				G49				
2.0								

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #954 Palmerston ave, Eastbound lane, 1.5 m North of South curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-08
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5526590, E-631357 (Palmerston Avenue)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		CONCRETE - 230 mm thick		PC22-27		
		CLAY - silty, trace sand - grey - frozen to 1.8 m depth, moist and firm to stiff when thawed - high plasticity - AASHTO: A-7-6 (39)		G50	●	△
0.5				G51	●	
1.0				G52	●	
				G53	●	
1.5		- stiff to very stiff below 1.5 m		G54	●	△ ✤
				G55	●	
2.0				G56	●	△ ✤

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #948 Palmerston ave, Westbound lane, 1.5 m South of North curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-09
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5526587, E-631460 (Palmerston Avenue)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 10 mm thick				
		CONCRETE - 210 mm thick		PC22-28		
		CLAY - silty, trace sand, trace organics - black - frozen to 1.8 m depth, moist and firm to stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G57	●	
0.5				G58	●	
		- brown, no organics below 0.9 m		G59	●	✤
1.0				G60	●	△ ✤
				G61	●	△ ✤
1.5				G62	●	△ ✤
				G63	●	△ ✤
2.0						

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #920 Palmerston ave, Westbound lane, 1.5 South of North curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-10
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5526623, E-631519 (Palmerston Avenue)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - 30 mm thick		
		CONCRETE - 180 mm thick		PC22-29
		CLAY - silty, trace sand - brown - frozen to 1.8 m depth, moist and stiff to very stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G64
0.5				G65
1.0				G66
				G67
1.5				G68
		- light brown below 1.8 m		G69
2.0				G70

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 2.3 m IN CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #910 Palmerston ave, Eastbound lane, 1.5 m North of South curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-11
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5526652, E-631557 (Palmerston Avenue)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 40 mm thick				
		CONCRETE - 130 mm thick		PC22-30		
		CLAY - silty, trace sand, trace organics - dark brown - frozen to 1.8 m depth, moist and very stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G71	●	
0.5				G72	●	
1.0				G73	●	
				G74	●	
1.5				G75	●	△ ✤
				G76	●	△ ✤
2.0		- brown, no organics below 2.0 m		G77	●	△ ✤

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #897 Palmerston ave, Westbound lane, 1.5 m South of North curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-12

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5526684, E-631619 (Palmerston Avenue)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
		ASPHALT - 90 mm thick				
		CONCRETE - 130 mm thick		PC22-31		
		CLAY - silty, trace sand, trace organics - dark brown - frozen to 1.8 m depth, moist and stiff to very stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G78	●	
0.5				G79	●	
1.0				G80	●	
				G81	●	
		- brown, no organics below 1.4 m				
1.5				G82	●	△ ✤
				G83	●	✤
2.0				G84	●	△ ✤

END OF TEST HOLE AT 2.3 m IN CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in front of #890 Palmerston ave, Eastbound lane, 1.5 m North of South curb.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

2022 Local Street Package - 22-R-05
Sub-Surface Investigation
Palmerston Avenue - between Ethelbert Street and Arlington Street

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH22-07	UTM : 14U 5526586 N, 631325 E Located in front of #954 Pamerston Ave, Eastbound lane, 1.5 m North of South curb.	Asphalt	30	Concrete	210	Clay; AASHTO: A-7-6 (I)	0.3	0.5	25							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	23							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	23							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	25							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	24							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	28							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	23							
TH22-08	UTM : 14U 5526590 N, 631357 E Located in front of #948 Pamerston Ave, Westbound lane, 1.5 m South of North curb.	Asphalt	-	Concrete	230	Clay; AASHTO: A-7-6 (39)	0.3	0.5	32							
						Clay; AASHTO: A-7-6 (39)	0.6	0.8	29							
						Clay; AASHTO: A-7-6 (39)	0.9	1.1	31	41	56	3	0	20	56	36
						Clay; AASHTO: A-7-6 (39)	1.2	1.4	31							
						Clay; AASHTO: A-7-6 (39)	1.5	1.7	30							
						Clay; AASHTO: A-7-6 (39)	1.8	2.0	25							
						Clay; AASHTO: A-7-6 (39)	2.1	2.3	36							
TH22-09	UTM : 14U 5526587 N, 631460 E Located in front of #920 Pamerston Ave, Westbound lane, 1.5 m South of North curb.	Asphalt	90	Concrete	210	Clay; AASHTO: A-7-6 (I)	0.3	0.5	35							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	30							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	28							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	27							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	28							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	27							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	27							
TH22-10	UTM : 14U 5526623 N, 631519 E Located in front of #910 Pamerston Ave, Eastbound lane, 1.5 m North of South curb.	Asphalt	30	Concrete	180	Clay; AASHTO: A-7-6 (I)	0.3	0.5	28							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	28							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	26							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	28							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	23							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	23							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	24							

(I) - AASHTO classification was interpreted based on visual classification.

2022 Local Street Package - 22-R-05
Sub-Surface Investigation
Palmerston Avenue - between Ethelbert Street and Arlington Street

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH22-11	UTM : 14U 5526652 N, 631557 E Located in front of #897 Pamerston Ave, Westbound lane, 1.5 m South of North curb.	Asphalt	40	Concrete	130	Clay; AASHTO: A-7-6 (I)	0.3	0.5	29							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	28							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	28							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	26							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	28							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	30							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	27							
TH22-12	UTM : 14U 5526684 N, 631619 E Located in front of #890 Pamerston Ave, Eastbound lane, 1.5 m North of South curb.	Asphalt	90	Concrete	130	Clay; AASHTO: A-7-6 (I)	0.3	0.5	32							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	31							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	31							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	32							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	29							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	29							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	28							

(I) - AASHTO classification was interpreted based on visual classification.

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05- Palmerston Ave

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-07	TH22-07	TH22-07	TH22-07	TH22-07	TH22-07
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0
Sample #	G43	G44	G45	G46	G47	G48
Tare ID	Z114	H13	F83	E42	F110	F99
Mass of tare	8.5	8.5	8.6	8.6	8.2	8.7
Mass wet + tare	174.7	183.6	181.6	258.0	254.7	233.4
Mass dry + tare	141.8	150.5	149.2	208.2	206.9	184.0
Mass water	32.9	33.1	32.4	49.8	47.8	49.4
Mass dry soil	133.3	142.0	140.6	199.6	198.7	175.3
Moisture %	24.7%	23.3%	23.0%	24.9%	24.1%	28.2%

Test Hole	TH22-07	TH22-08	TH22-08	TH22-08	TH22-08	TH22-08
Depth (m)	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7
Sample #	G49	G50	G51	G52	G53	G54
Tare ID	F79	H60	P11	Z105	H69	W65
Mass of tare	8.8	8.8	8.5	8.4	9.5	8.4
Mass wet + tare	278.8	252.8	185.9	408.8	208.5	216.3
Mass dry + tare	228.0	193.4	146.1	314.7	161.7	168.0
Mass water	50.8	59.4	39.8	94.1	46.8	48.3
Mass dry soil	219.2	184.6	137.6	306.3	152.2	159.6
Moisture %	23.2%	32.2%	28.9%	30.7%	30.7%	30.3%

Test Hole	TH22-08	TH22-08	TH22-09	TH22-09	TH22-09	TH22-09
Depth (m)	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4
Sample #	G55	G56	G57	G58	G59	G60
Tare ID	E2	Z14	Z120	AB50	Z52	Z41
Mass of tare	8.6	8.6	8.9	6.8	8.6	8.5
Mass wet + tare	203.0	216.6	263.8	229.4	206.4	195.9
Mass dry + tare	164.1	161.5	198.1	177.7	163.2	156.6
Mass water	38.9	55.1	65.7	51.7	43.2	39.3
Mass dry soil	155.5	152.9	189.2	170.9	154.6	148.1
Moisture %	25.0%	36.0%	34.7%	30.3%	27.9%	26.5%

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05- Palmerston Ave

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-09	TH22-09	TH22-09	TH22-10	TH22-10	TH22-10
Depth (m)	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1
Sample #	G61	G62	G63	G64	G65	G66
Tare ID	F133	P10	F153	W07	Z51	N52
Mass of tare	8.4	8.4	8.4	8.6	8.5	8.7
Mass wet + tare	243.8	207.7	226.3	169.4	191.4	240.4
Mass dry + tare	192.4	165.8	180.0	133.9	151.7	193.1
Mass water	51.4	41.9	46.3	35.5	39.7	47.3
Mass dry soil	184.0	157.4	171.6	125.3	143.2	184.4
Moisture %	27.9%	26.6%	27.0%	28.3%	27.7%	25.7%

Test Hole	TH22-10	TH22-10	TH22-10	TH22-10	TH22-11	TH22-11
Depth (m)	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8
Sample #	G67	G68	G69	G70	G71	G72
Tare ID	A3	AB13	N01	AC27	AB12	C28
Mass of tare	8.4	6.7	8.4	7.0	7.1	8.3
Mass wet + tare	185.7	215.7	224.6	242.6	261.3	211.5
Mass dry + tare	147.4	176.1	184.2	197.3	204.4	167.2
Mass water	38.3	39.6	40.4	45.3	56.9	44.3
Mass dry soil	139.0	169.4	175.8	190.3	197.3	158.9
Moisture %	27.6%	23.4%	23.0%	23.8%	28.8%	27.9%

Test Hole	TH22-11	TH22-11	TH22-11	TH22-11	TH22-11	TH22-12
Depth (m)	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5
Sample #	G73	G74	G75	G76	G77	G78
Tare ID	C8	F141	F60	H03	F17	W30
Mass of tare	8.4	8.7	8.6	8.5	8.3	8.4
Mass wet + tare	168.5	161.4	280.2	248.9	223.8	181.3
Mass dry + tare	133.7	130.2	220.1	193.1	178.3	139.7
Mass water	34.8	31.2	60.1	55.8	45.5	41.6
Mass dry soil	125.3	121.5	211.5	184.6	170.0	131.3
Moisture %	27.8%	25.7%	28.4%	30.2%	26.8%	31.7%

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05- Palmerston Ave

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-12	TH22-12	TH22-12	TH22-12	TH22-12	TH22-12
Depth (m)	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3
Sample #	G79	G80	G81	G82	G83	G84
Tare ID	W04	N04	A17	W92	AB05	W90
Mass of tare	8.4	8.6	8.5	8.4	6.6	8.4
Mass wet + tare	242.5	224.2	196.4	218.4	215.9	235.7
Mass dry + tare	186.5	172.9	150.6	171.3	168.4	185.8
Mass water	56.0	51.3	45.8	47.1	47.5	49.9
Mass dry soil	178.1	164.3	142.1	162.9	161.8	177.4
Moisture %	31.4%	31.2%	32.2%	28.9%	29.4%	28.1%

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Atterberg Limits
ASTM D4318-10e1

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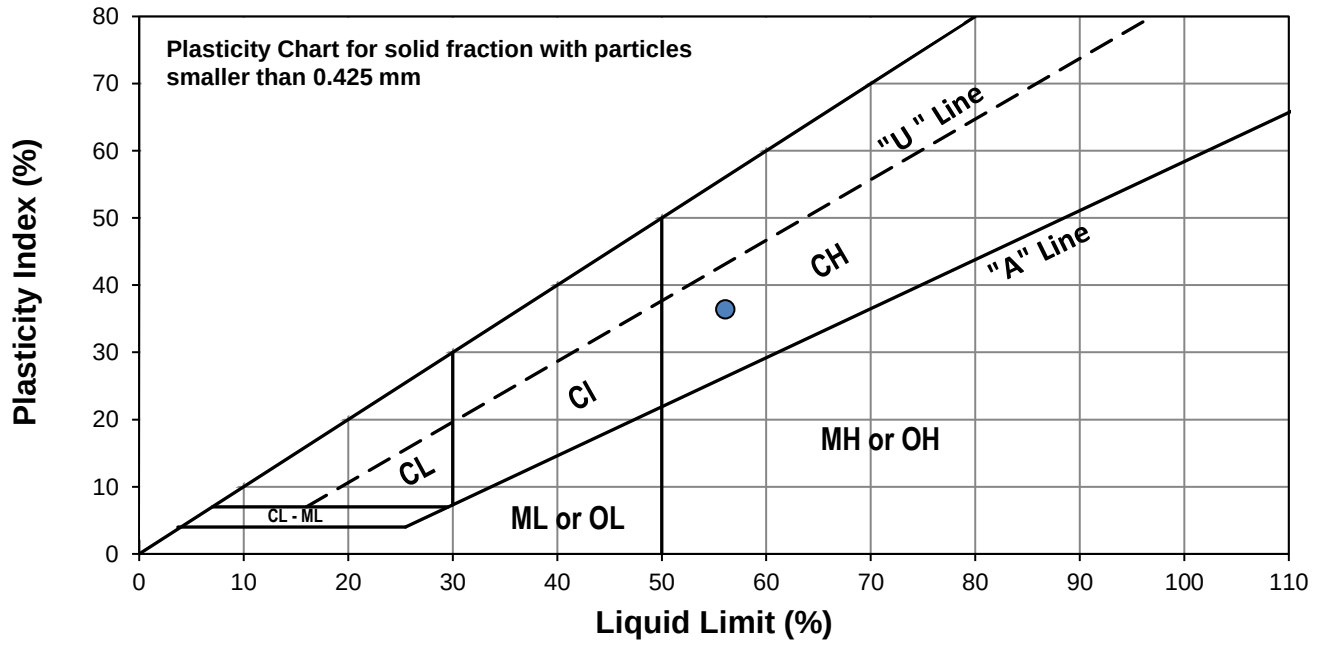
Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05-Palmerston Ave
Test Hole	TH22-08
Sample #	G52
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	14-Feb-22
Technician	NM

Liquid Limit	56
Plastic Limit	20
Plasticity Index	36

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	16	26	35		
Mass Tare (g)	14.315	14.235	13.970		
Mass Wet Soil + Tare (g)	26.264	24.978	25.784		
Mass Dry Soil + Tare (g)	21.853	21.120	21.638		
Mass Water (g)	4.411	3.858	4.146		
Mass Dry Soil (g)	7.538	6.885	7.668		
Moisture Content (%)	58.517	56.035	54.069		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.157	14.101			
Mass Wet Soil + Tare (g)	24.606	24.763			
Mass Dry Soil + Tare (g)	22.890	23.005			
Mass Water (g)	1.716	1.758			
Mass Dry Soil (g)	8.733	8.904			
Moisture Content (%)	19.650	19.744			

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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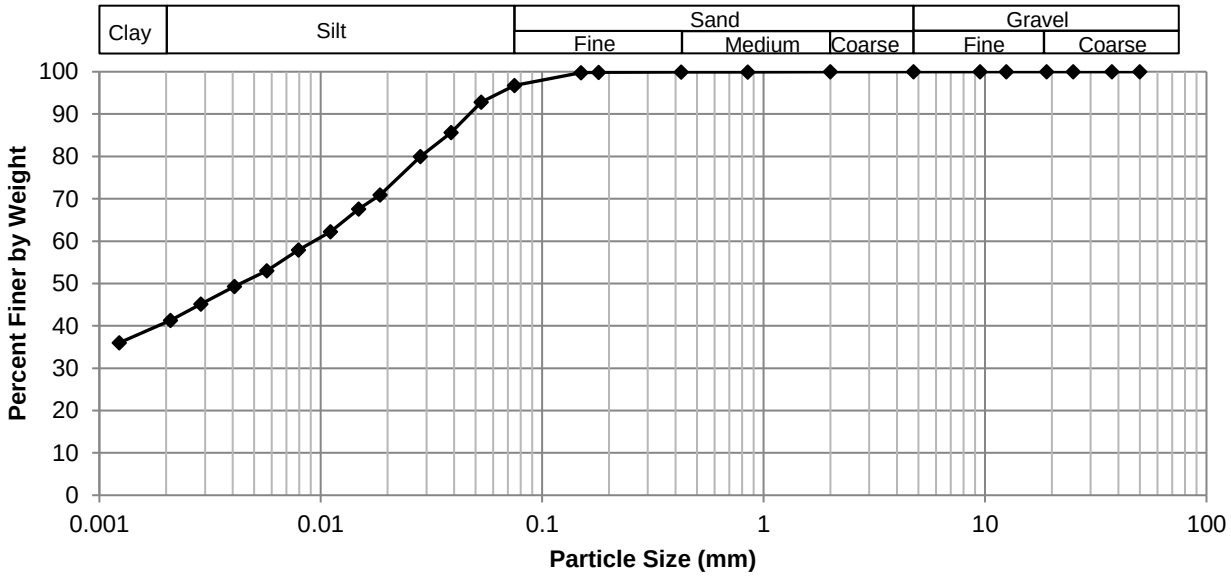
Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05-Palmerston Ave
Test Hole	TH22-08
Sample #	G52
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.0%
Sand	3.3%
Silt	56.0%
Clay	40.7%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	96.73
37.5	100.00	2.00	100.00	0.0531	92.83
25.0	100.00	0.850	99.97	0.0388	85.64
19.0	100.00	0.425	99.93	0.0282	80.01
12.5	100.00	0.180	99.86	0.0185	70.94
9.50	100.00	0.150	99.79	0.0148	67.57
4.75	100.00	0.075	96.73	0.0111	62.25
				0.0079	57.94
				0.0057	53.00
				0.0041	49.31
				0.0029	45.18
				0.0021	41.30
				0.0012	35.99

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Standard Proctor Compaction Test

ASTM D698-12e2

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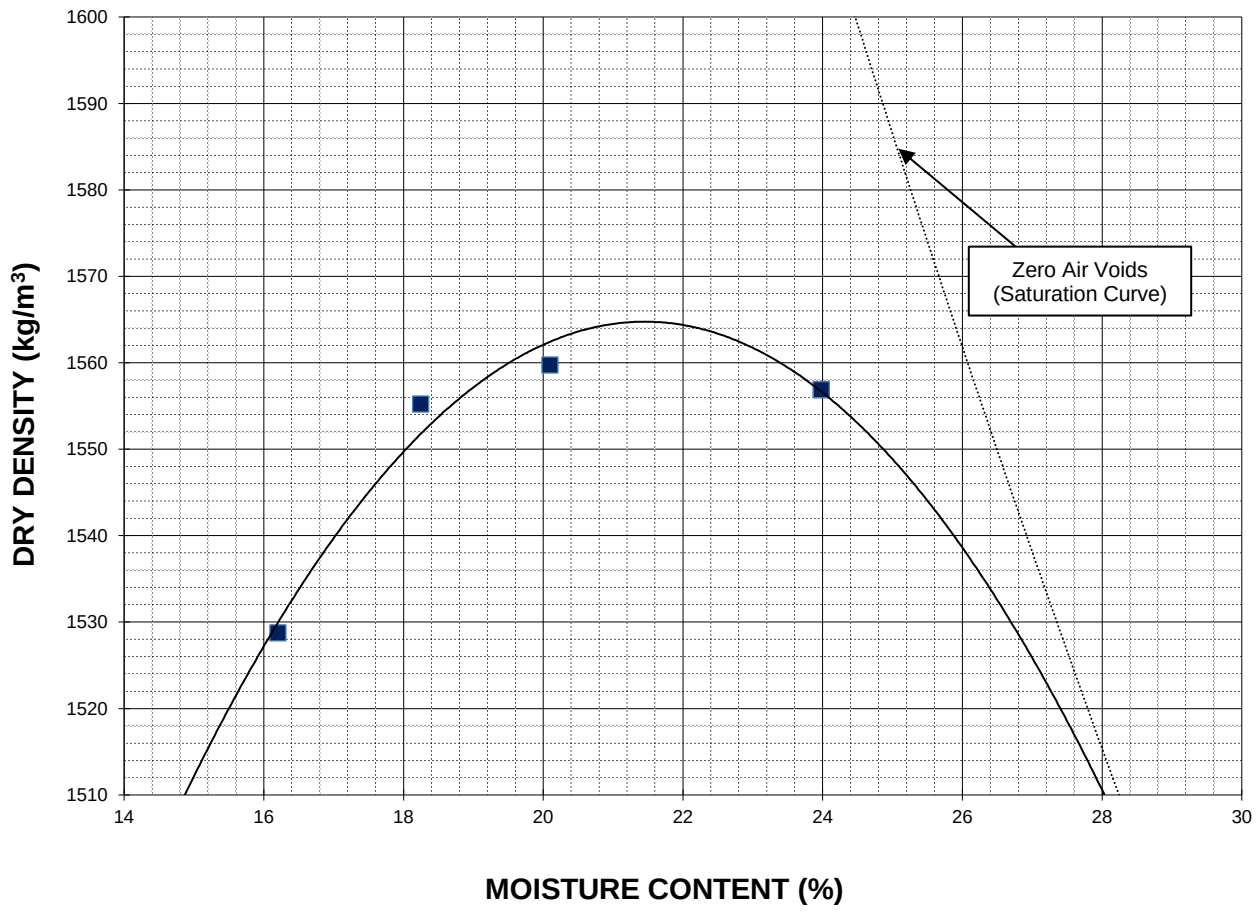
Project No.	1000-043-19
Client	WSP
Project	2022 Local Streets Package
Sample #	Combined bulk samples
Source	TH22-07, 08, 09 (Palmerston Ave.)
Material	Clay
Sample Date	07-Feb-22
Test Date	10-Feb-22
Technician	RS

Maximum Dry Density (kg/m3)	1565
Optimum Moisture (%)	21.5

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1776	1839	1873	1930	
Dry Density (kg/m^3)	1529	1555	1560	1557	
Moisture Content (%)	16.2	18.2	20.1	24.0	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-07, 08, 09
Client	WSP	**Material**	Clay
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Palmerston Ave)	**Test Date**	2022-02-16
		Technician	RS

Proctor Results (ASTM D698)

Maximum Dry Density	1565	kg/m3
Optimum Moisture Content	21.5	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1479	kg/m3
Initial Moisture Content	23.3	%
Relative Density	94.5	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.7	%
Moisture Content in top 25 mm	29.7	%
Immersion Period	96	h

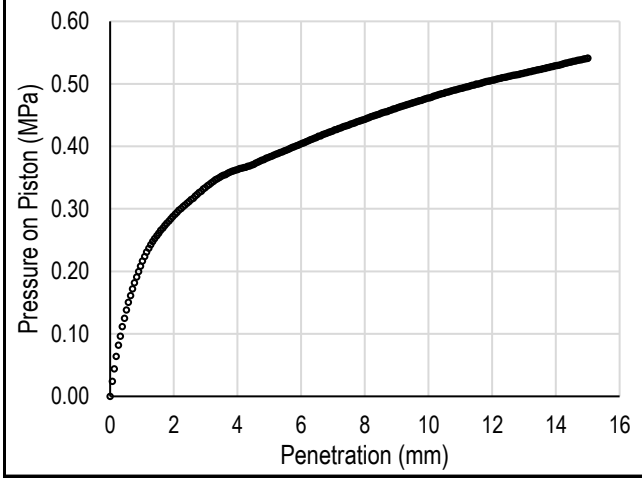
CBR Results

CBR at 2.54 mm	4.6	%
CBR at 5.08 mm	3.7	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.16	0.16
1.27	0.24	0.24
1.91	0.28	0.28
2.54	0.32	0.32
3.18	0.34	0.34
3.81	0.36	0.36
4.45	0.37	0.37
5.08	0.38	0.38
7.62	0.44	0.44
10.16	0.48	0.48
12.70	0.51	0.51

Load/Penetration Curve



Comments:

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Standard Proctor Compaction Test

ASTM D698-12e2

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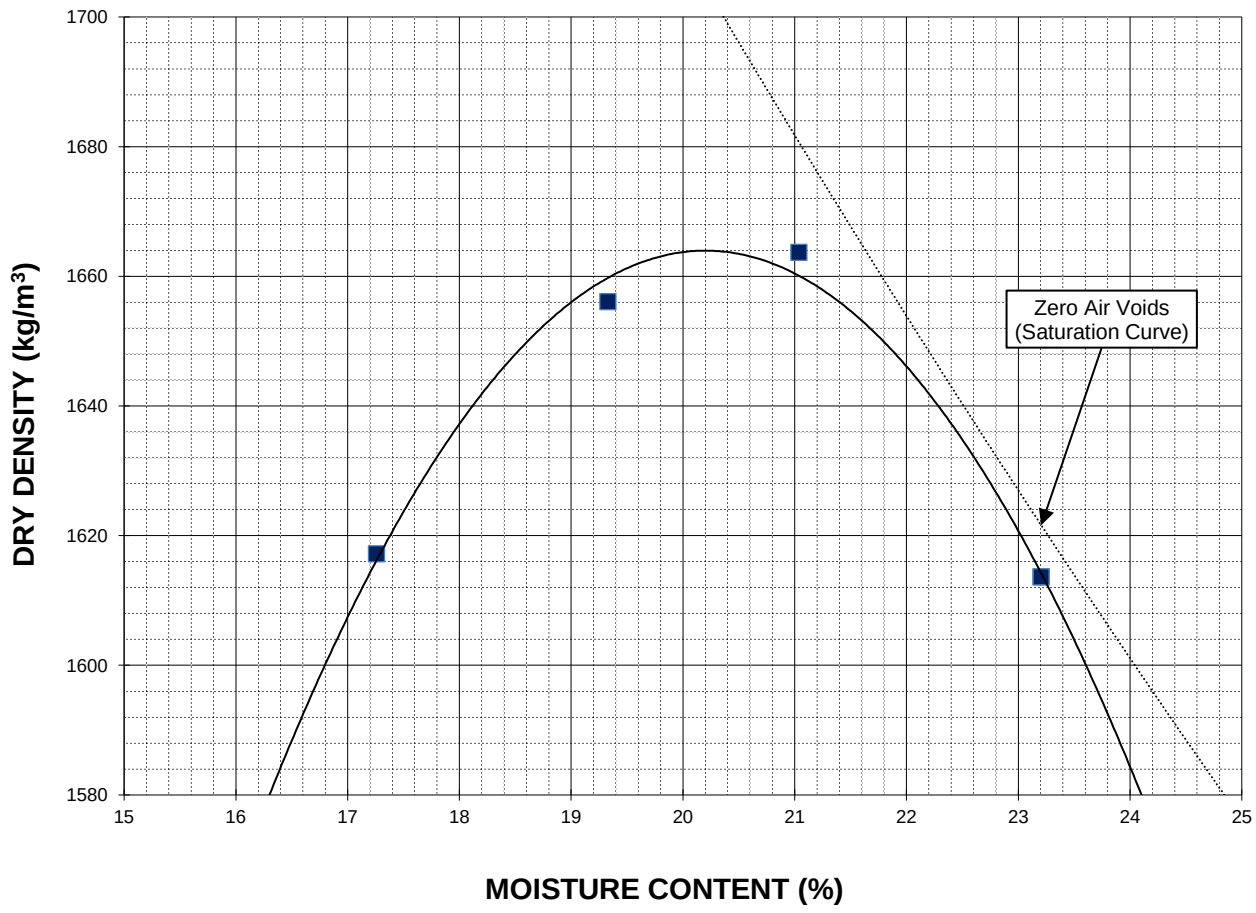
Project No.	1000-043-19
Client	WSP
Project	2022 Local Street Package
Sample #	Combined bulk samples
Source	TH22-10, 11, 12 (Palmerston Ave)
Material	Clay
Sample Date	07-Feb-22
Test Date	09-Feb-22
Technician	DS

Maximum Dry Density (kg/m3)	1664
Optimum Moisture (%)	20.2

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1896	1976	2014	1988	
Dry Density (kg/m^3)	1617	1656	1664	1614	
Moisture Content (%)	17.3	19.3	21.0	23.2	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-10, 11, 12
Client	WSP	**Material**	Clay
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Palmerston Ave.)	**Test Date**	2022-02-11
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1664	kg/m3
Optimum Moisture Content	20.2	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1575	kg/m3
Initial Moisture Content	21.5	%
Relative Density	94.7	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.7	%
Moisture Content in top 25 mm	26.2	%
Immersion Period	96	h

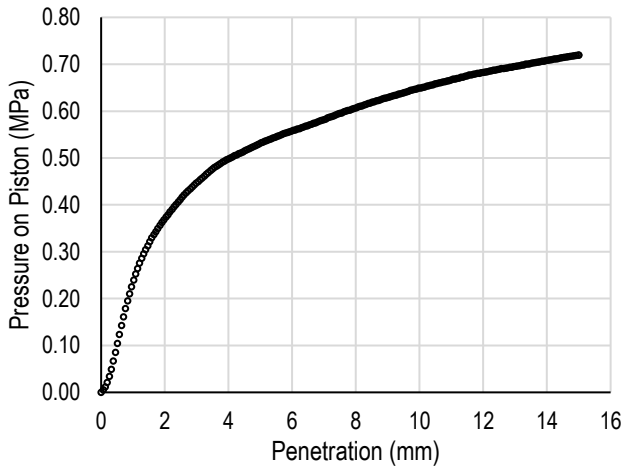
CBR Results

CBR at 2.54 mm	6.0	%
CBR at 5.08 mm	5.2	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.14	0.14
1.27	0.29	0.29
1.91	0.36	0.36
2.54	0.42	0.42
3.18	0.46	0.46
3.81	0.49	0.49
4.45	0.51	0.51
5.08	0.53	0.53
7.62	0.60	0.60
10.16	0.65	0.65
12.70	0.69	0.69

Load/Penetration Curve



Comments:

Photo 1: Pavement Core Sample at Test Hole TH22-07

Photo 2: Pavement Core Sample at Test Hole TH22-08

Photo 3: Pavement Core Sample at Test Hole TH22-09

Photo 4: Pavement Core Sample at Test Hole TH22-10

Photo 5: Pavement Core Sample at Test Hole TH22-11

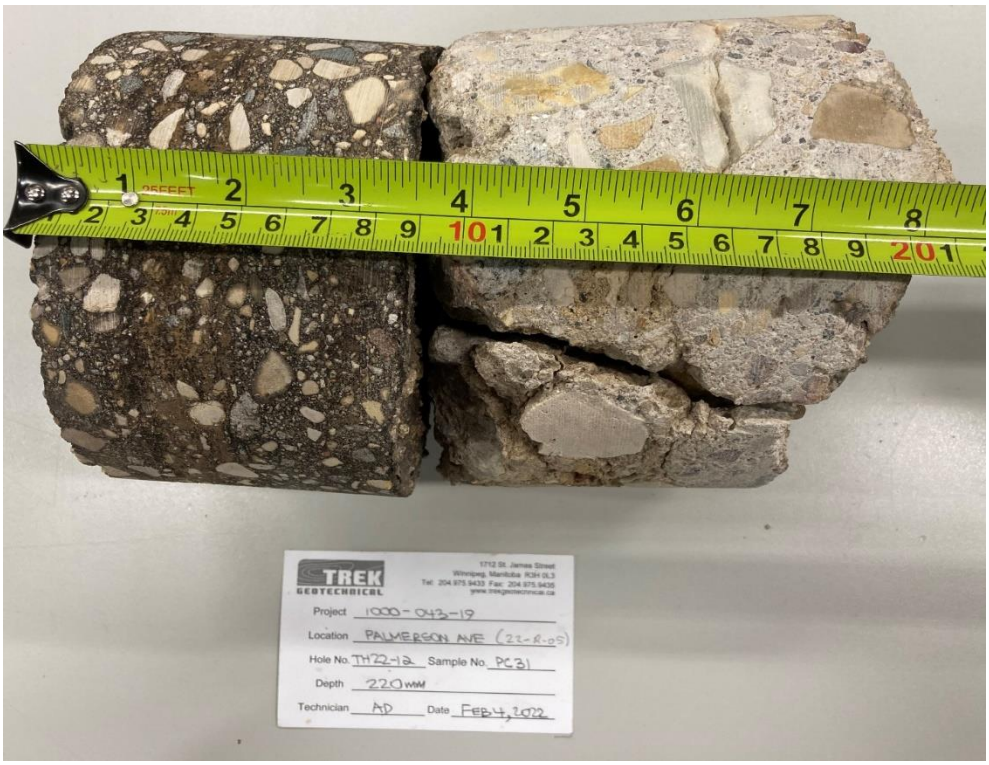


Photo 6: Pavement Core Sample at Test Hole TH22-12

Appendix D

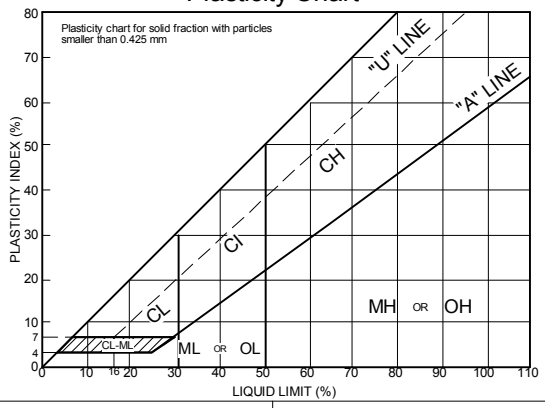
Test Hole Logs, Summary Table & Lab Testing Results and Pavement Core Photos – Sargent Ave/Spruce St Alley

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent..... GW, GP, SW, SP; More than 12 percent..... GM, GC, SM, SC; 6 to 12 percent..... Borderline case4s requiring dual symbols*
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures	Not meeting all gradation requirements for GW
			GC		Clayey gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP		Poorly-graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL		Organic silts and organic silty clays of low plasticity	
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts	
			CH		Inorganic clays of high plasticity, fat clays	
			OH		Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit: Strong colour or odour, and often fibrous texture



Particle Size	Material	ASTM Sieve sizes	mm
	Sand		
	Coarse	#10 to #4	2.00 to 4.75
	Medium	#40 to #10	0.425 to 2.00
	Fine	#200 to #40	0.075 to 0.425
	Silt or Clay	< #200	< 0.075

Particle Size	Material	ASTM Sieve Sizes	mm
	Boulders	> 12 in.	> 300
	Cobbles	3 in. to 12 in.	75 to 300
	Gravel		
	Coarse	3/4 in. to 3 in.	19 to 75
	Fine	#4 to 3/4 in.	4.75 to 19

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH22-13
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528596, E-630285 (Spruce St/Clifton St Alley)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21	Particle Size (%) 0 20 40 60 80 100 PL MC LL	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
		CONCRETE - 180 mm thick		PC22-32			
		CLAY - silty, trace sand - grey - frozen to 1.5 m depth, moist and stiff to very stiff when thawed - high plasticity - AASHTO: A-7-6 (I)		G85			
0.5				G86			
				G87			
1.0				G88			
				G89			
1.5				G90			
				G91			
2.0							

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in back alley of house #992 Clifton street, 1 m North of South edge of alley.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-14
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528546, E-630243 (Spruce St/Clifton St Alley)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 8, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		CONCRETE - 260 mm thick		PC22-33		
		SILT and CLAY - some sand, trace organics - black - frozen, moist and firm when thawed - intermediate plasticity - AASHTO: A-7-6 (24)		G92		
0.5				G93		
1.0				G94		
		- brown, no organics below 1.3 m		G95		
1.5		SILT - some sand, some clay - light brown - frozen to 1.5 m depth, moist and soft when thawed - low to intermediate plasticity - AASHTO: A-4 (I)		G96		
		CLAY - silty - brown - moist, stiff - high plasticity - AASHTO: A-7-6 (I)		G97		
2.0				G98		

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in back alley of house #1065 Spruce street, 1.5 m West of East edge of alley.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

Sub-Surface Log

Test Hole TH22-15

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528703, E-630245 (Spruce St/Clifton St Alley)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 7, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
		ASPHALT - 20 mm thick				
		CONCRETE - 270 mm thick		PC22-34		
		CLAY - silty, trace sand, trace organics - black - frozen to 1.5 m depth, moist and soft to firm when thawed - high plasticity - AASHTO: A-7-6 (45)		G99	●	
0.5				G100	●	✿
1.0				G101	●	✿
		- brown, no organics below 1.2 m		G102	●	✿
1.5		- firm to stiff below 1.5 m		G103	●	✿
				G104	●	✿
2.0		- light brown below 2.0 m		G105	●	✿

END OF TEST HOLE AT 2.3 m IN CLAY

1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in back alley of house #1115 Spruce street, 2 m East of West edge of alley.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH22-16
1 of 1

Client:	WSP Canada Inc	**Project Number:**	1000-043-19
Project Name:	Local Street Package 22-R-05	**Location:**	UTM N-5528757, E-630296 (Spruce St/Clifton St Alley)
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Top of Pavement
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	February 7, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - 30 mm thick				
		CONCRETE - 250 mm thick		PC22-35		
		CLAY - silty, trace sand, trace organics - black - frozen, moist and firm when thawed - high plasticity - AASHTO: A-7-6 (I)		G106	MC ●	
0.5						
		SILT - some sand, some clay, trace organics - light brown - frozen to 1.5 m depth, moist and soft when thawed - low to intermediate plasticity - AASHTO: A-4 (3)		G107	MC ●	
1.0				G108	PL ● MC LL	
				G109	MC ●	
1.5		CLAY - silty - brown - moist, stiff - high plasticity - AASHTO: A-7-6 (I)		G110	MC ●	
				G111	MC ●	△✤
2.0				G112	MC ●	△✤

END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in back alley of house #1038 Clifton street, 2 m North of South edge of alley.
5) The bulk sample was collected between 0.3 m and 1.5 m depth.

Logged By: Asad Dustmamatov **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2022-02-08_LOCAL STREET PACKAGE 22-R-05_1000-043-19_A_AD.GPJ TREK.GDT 2/24/22

2022 Local Street Package - 22-R-05
Sub-Surface Investigation
Spruce Street/Clifton Street Alley - between Sargent Avenue and Ellice Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH22-13	UTM : 14U 5528596 N, 630285 E Located in back alley of house #992 Clifton St., 1.0 m North of South edge of alley.	Asphalt	-	Concrete	180	Clay; AASHTO: A-7-6 (I)	0.3	0.5	29							
						Clay; AASHTO: A-7-6 (I)	0.6	0.8	32							
						Clay; AASHTO: A-7-6 (I)	0.9	1.1	35							
						Clay; AASHTO: A-7-6 (I)	1.2	1.4	35							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	36							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	40							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	43							
TH22-14	UTM : 14U 5528546 N, 630243 E Located in back alley of house #1065 Spruce St., 1.5 m West of East edge of alley.	Asphalt	-	Concrete	260	Silt and Clay; AASHTO: A-7-6 (24)	0.3	0.5	39							
						Silt and Clay; AASHTO: A-7-6 (24)	0.6	0.8	32							
						Silt and Clay; AASHTO: A-7-6 (24)	0.9	1.1	31	38	51	11	0	16	43	27
						Silt and Clay; AASHTO: A-7-6 (24)	1.2	1.4	29							
						Silt; AASHTO: A-4 (I)	1.5	1.7	10							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	40							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	40							
TH22-15	UTM : 14U 5528703 N, 630245 E Located in back alley of house #1115 Spruce St., 2.0 m East of West edge of alley.	Asphalt	20	Concrete	270	Clay; AASHTO: A-7-6 (45)	0.3	0.5	30							
						Clay; AASHTO: A-7-6 (45)	0.6	0.8	30							
						Clay; AASHTO: A-7-6 (45)	0.9	1.1	30	58	35	7	0	17	62	45
						Clay; AASHTO: A-7-6 (45)	1.2	1.4	30							
						Clay; AASHTO: A-7-6 (45)	1.5	1.7	34							
						Clay; AASHTO: A-7-6 (45)	1.8	2.0	44							
						Clay; AASHTO: A-7-6 (45)	2.1	2.3	40							
TH22-16	UTM : 14U 5528596 N, 630285 E Located in back alley of house #1038 Clifton St. back alley, 2.0 m North of South edge of alley.	Asphalt	30	Concrete	250	Clay; AASHTO: A-7-6 (I)	0.3	0.5	37							
						Silt; AASHTO: A-4 (3)	0.6	0.8	26							
						Silt; AASHTO: A-4 (3)	0.9	1.1	26	15	74	11	0	18	24	6
						Silt; AASHTO: A-4 (3)	1.2	1.4	26							
						Clay; AASHTO: A-7-6 (I)	1.5	1.7	23							
						Clay; AASHTO: A-7-6 (I)	1.8	2.0	36							
						Clay; AASHTO: A-7-6 (I)	2.1	2.3	42							

.

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05 - Spruce Clifton Alley

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-13	TH22-13	TH22-13	TH22-13	TH22-13	TH22-13
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0
Sample #	G85	G86	G87	G88	G89	G90
Tare ID	F48	C13	N15	E46	Z81	N112
Mass of tare	8.5	8.4	8.5	8.4	8.6	8.3
Mass wet + tare	184.8	213.2	155.8	137.0	198.2	177.5
Mass dry + tare	145.3	163.8	117.3	103.5	147.8	129.1
Mass water	39.5	49.4	38.5	33.5	50.4	48.4
Mass dry soil	136.8	155.4	108.8	95.1	139.2	120.8
Moisture %	28.9%	31.8%	35.4%	35.2%	36.2%	40.1%

Test Hole	TH22-13	TH22-14	TH22-14	TH22-14	TH22-14	TH22-14
Depth (m)	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7
Sample #	G91	G92	G93	G94	G95	G96
Tare ID	F63	P36	AB87	H50	A102	F137
Mass of tare	8.4	8.5	6.7	8.4	8.3	8.6
Mass wet + tare	188.5	177.0	170.8	376.0	167.2	311.5
Mass dry + tare	134.3	130.2	131.4	289.3	131.3	283.6
Mass water	54.2	46.8	39.4	86.7	35.9	27.9
Mass dry soil	125.9	121.7	124.7	280.9	123.0	275.0
Moisture %	43.1%	38.5%	31.6%	30.9%	29.2%	10.1%

Test Hole	TH22-14	TH22-14	TH22-15	TH22-15	TH22-15	TH22-15
Depth (m)	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4
Sample #	G97	G98	G99	G100	G101	G102
Tare ID	AB57	Z09	P05	Z75	N91	AA20
Mass of tare	6.6	8.4	8.6	8.6	8.7	6.7
Mass wet + tare	211.5	186.6	205.7	300.8	447.8	317.0
Mass dry + tare	153.1	135.6	160.3	233.3	345.5	245.0
Mass water	58.4	51.0	45.4	67.5	102.3	72.0
Mass dry soil	146.5	127.2	151.7	224.7	336.8	238.3
Moisture %	39.9%	40.1%	29.9%	30.0%	30.4%	30.2%

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Moisture Content Report
ASTM D2216-10

Project No. 1000-043-19
Client WSP Canada Inc
Project Street Package 22-R-05 - Spruce Clifton Alley

Sample Date 07-Feb-22
Test Date 09-Feb-22
Technician AD

Test Hole	TH22-15	TH22-15	TH22-15	TH22-16	TH22-16	TH22-16
Depth (m)	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1
Sample #	G103	G104	G105	G106	G107	G108
Tare ID	AA50	W25	D40	W79	A104	W53
Mass of tare	6.7	8.4	8.3	8.7	8.5	8.4
Mass wet + tare	344.3	251.7	208.9	278.1	288.5	405.1
Mass dry + tare	259.0	177.8	151.2	204.9	230.3	324.0
Mass water	85.3	73.9	57.7	73.2	58.2	81.1
Mass dry soil	252.3	169.4	142.9	196.2	221.8	315.6
Moisture %	33.8%	43.6%	40.4%	37.3%	26.2%	25.7%

Test Hole	TH22-16	TH22-16	TH22-16	TH22-16		
Depth (m)	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3		
Sample #	G109	G110	G111	G112		
Tare ID	N36	W87	A8	E33		
Mass of tare	8.4	8.5	8.1	8.5		
Mass wet + tare	231.8	288.8	240.9	193.6		
Mass dry + tare	186.4	236.9	179.4	138.9		
Mass water	45.4	51.9	61.5	54.7		
Mass dry soil	178.0	228.4	171.3	130.4		
Moisture %	25.5%	22.7%	35.9%	41.9%		

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Atterberg Limits
ASTM D4318-10e1

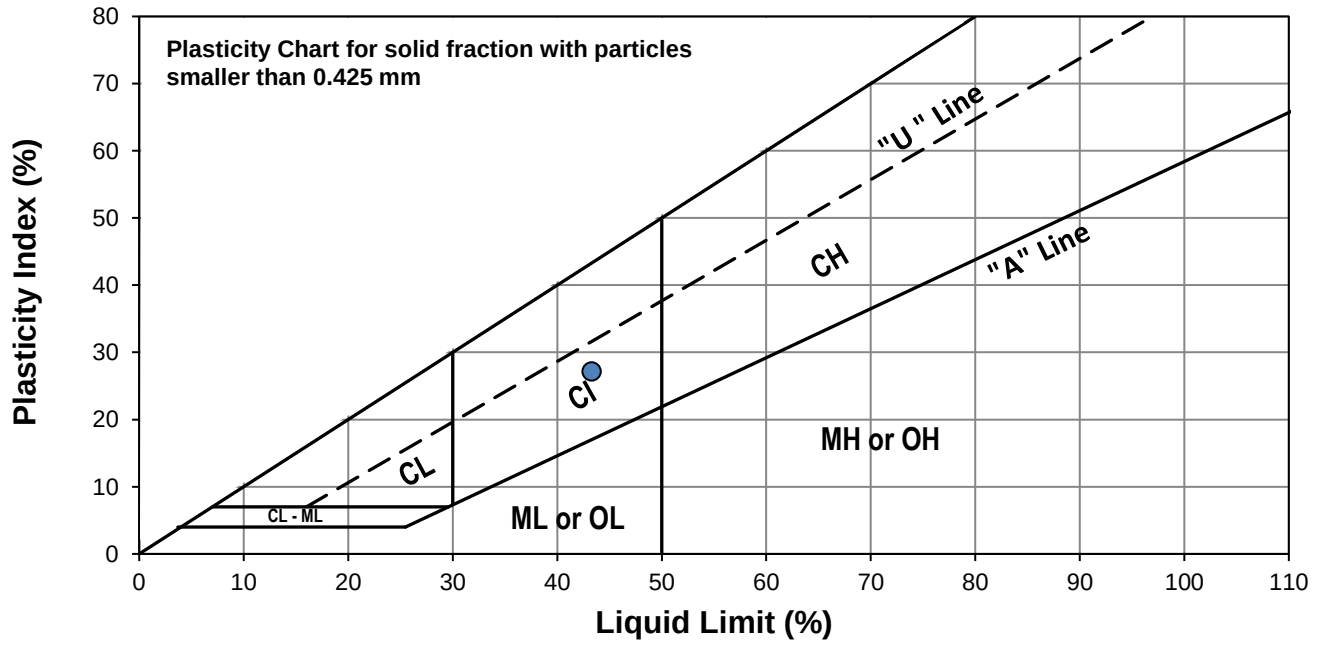
CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05-Spruce Clifton Alley
Test Hole	TH22-14
Sample #	G94
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	11-Feb-22
Technician	AD

Liquid Limit	43
Plastic Limit	16
Plasticity Index	27

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	20	30		
Mass Tare (g)	14.081	13.993	14.178		
Mass Wet Soil + Tare (g)	27.772	25.840	27.779		
Mass Dry Soil + Tare (g)	23.473	22.186	23.736		
Mass Water (g)	4.299	3.654	4.043		
Mass Dry Soil (g)	9.392	8.193	9.558		
Moisture Content (%)	45.773	44.599	42.300		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.212	14.066			
Mass Wet Soil + Tare (g)	23.013	21.604			
Mass Dry Soil + Tare (g)	21.798	20.547			
Mass Water (g)	1.215	1.057			
Mass Dry Soil (g)	7.586	6.481			
Moisture Content (%)	16.016	16.309			

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Atterberg Limits
ASTM D4318-10e1

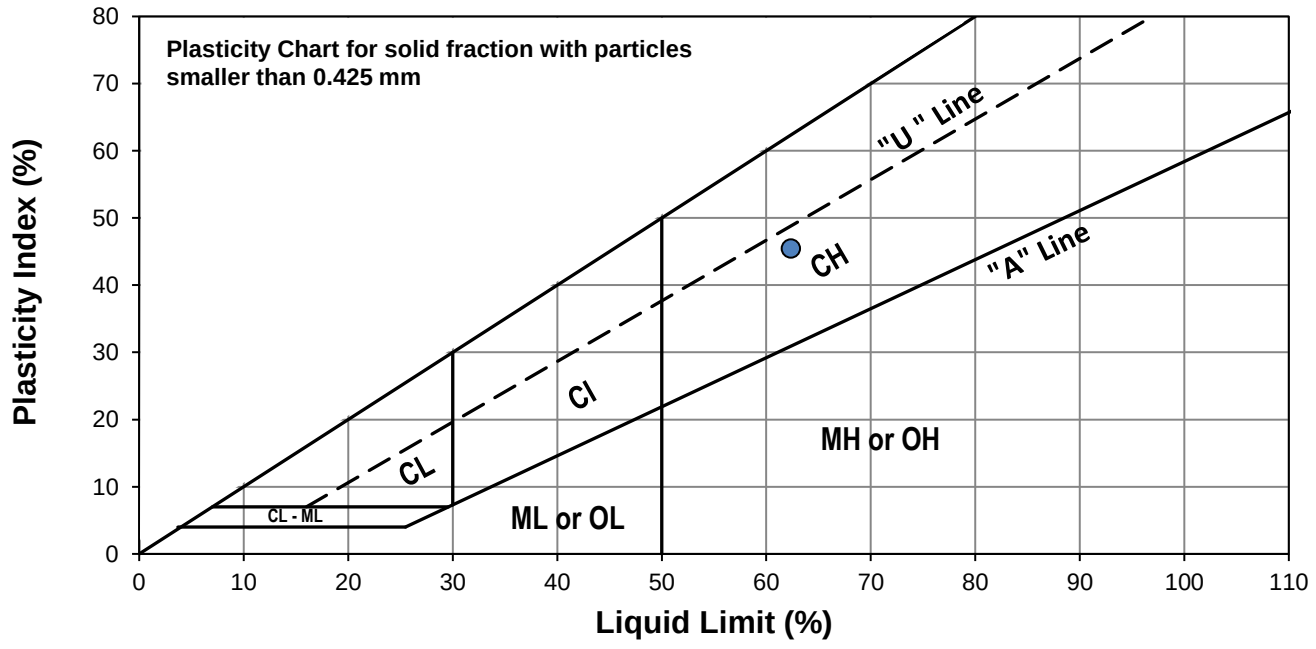
CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05-Spruce Clifton Alley
Test Hole	TH22-15
Sample #	G101
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	11-Feb-22
Technician	AD

Liquid Limit	62
Plastic Limit	17
Plasticity Index	45

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	19	29	33		
Mass Tare (g)	14.101	13.974	14.078		
Mass Wet Soil + Tare (g)	23.374	23.923	24.932		
Mass Dry Soil + Tare (g)	19.761	20.131	20.830		
Mass Water (g)	3.613	3.792	4.102		
Mass Dry Soil (g)	5.660	6.157	6.752		
Moisture Content (%)	63.834	61.588	60.752		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.002	14.059			
Mass Wet Soil + Tare (g)	21.798	20.112			
Mass Dry Soil + Tare (g)	20.675	19.234			
Mass Water (g)	1.123	0.878			
Mass Dry Soil (g)	6.673	5.175			
Moisture Content (%)	16.829	16.966			

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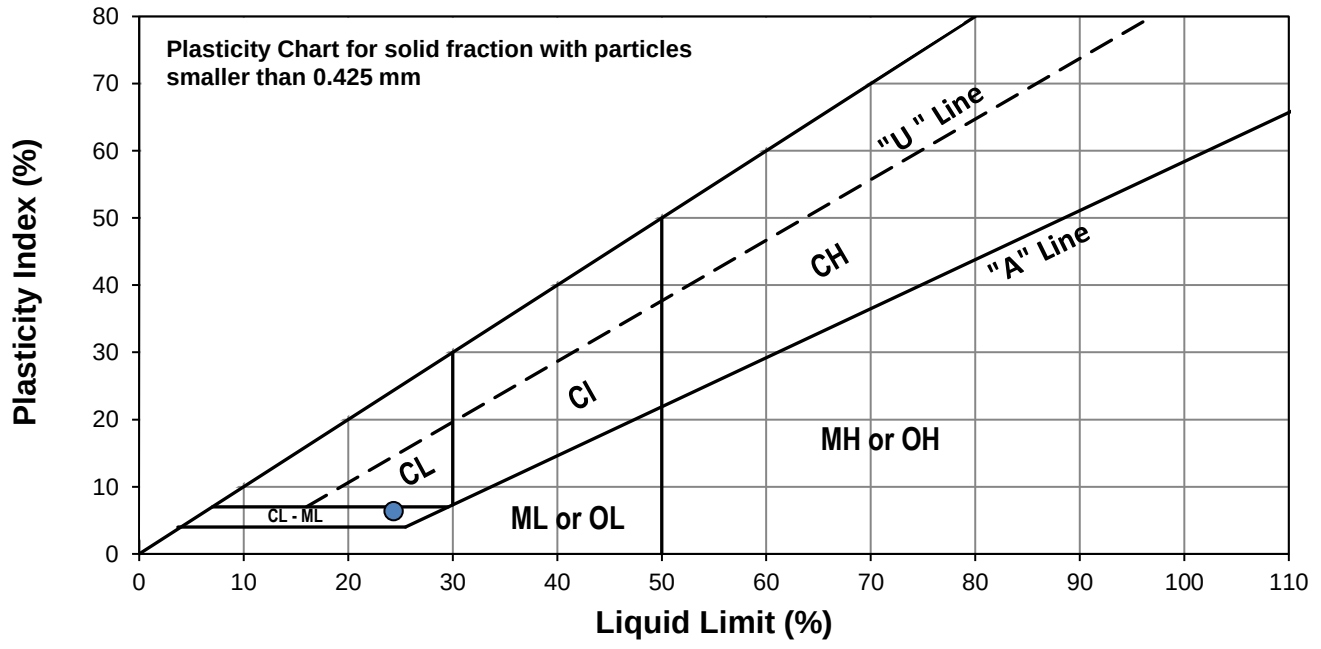
Atterberg Limits
ASTM D4318-10e1

Project No.	1000-043-19
Client	WSP Canada Inc
Project	Local Street Package 22-R-05- Spruce Clifton Alley
Test Hole	TH22-16
Sample #	G108
Depth (m)	0.9 - 1.1
Sample Date	07-Feb-22
Test Date	11-Feb-22
Technician	AD

Liquid Limit	24
Plastic Limit	18
Plasticity Index	6

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	21	31		
Mass Tare (g)	14.048	14.208	14.285		
Mass Wet Soil + Tare (g)	28.726	26.420	29.072		
Mass Dry Soil + Tare (g)	25.727	23.972	26.261		
Mass Water (g)	2.999	2.448	2.811		
Mass Dry Soil (g)	11.679	9.764	11.976		
Moisture Content (%)	25.679	25.072	23.472		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	13.944	14.062			
Mass Wet Soil + Tare (g)	21.435	22.858			
Mass Dry Soil + Tare (g)	20.302	21.505			
Mass Water (g)	1.133	1.353			
Mass Dry Soil (g)	6.358	7.443			
Moisture Content (%)	17.820	18.178			

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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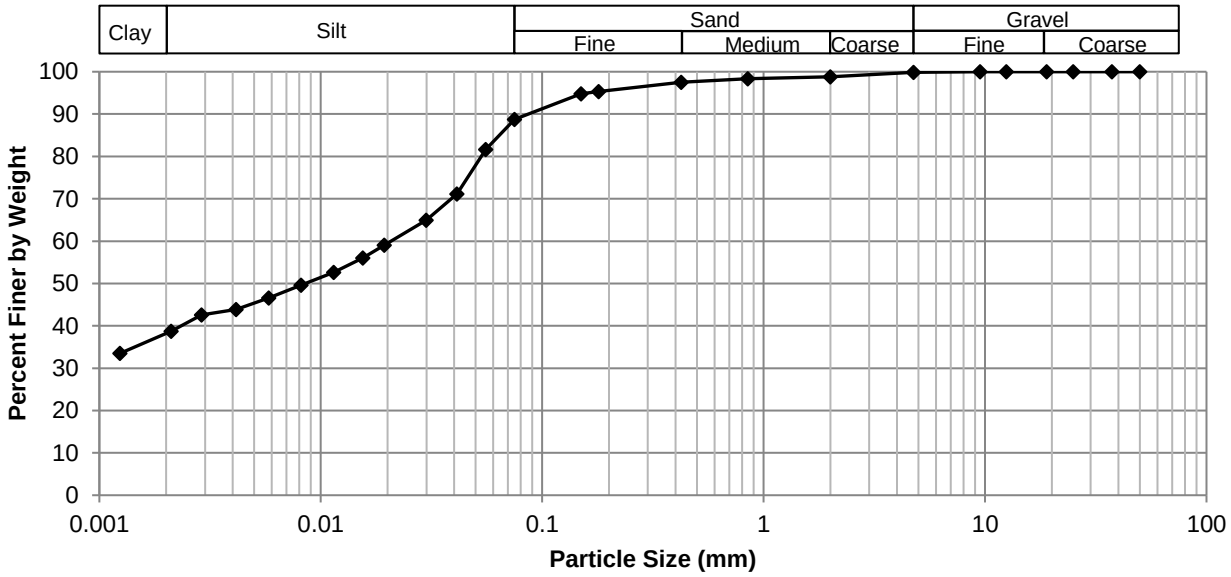
Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05-Spruce Clifton Alley
Test Hole	TH22-14
Sample #	G94
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.1%
Sand	11.1%
Silt	50.7%
Clay	38.1%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	99.89	0.0750	88.74
37.5	100.00	2.00	98.81	0.0557	81.64
25.0	100.00	0.850	98.34	0.0412	71.14
19.0	100.00	0.425	97.53	0.0299	64.96
12.5	100.00	0.180	95.34	0.0194	59.09
9.50	100.00	0.150	94.82	0.0155	56.00
4.75	99.89	0.075	88.74	0.0114	52.66
				0.0082	49.63
				0.0058	46.60
				0.0042	43.88
				0.0029	42.58
				0.0021	38.74
				0.0012	33.49

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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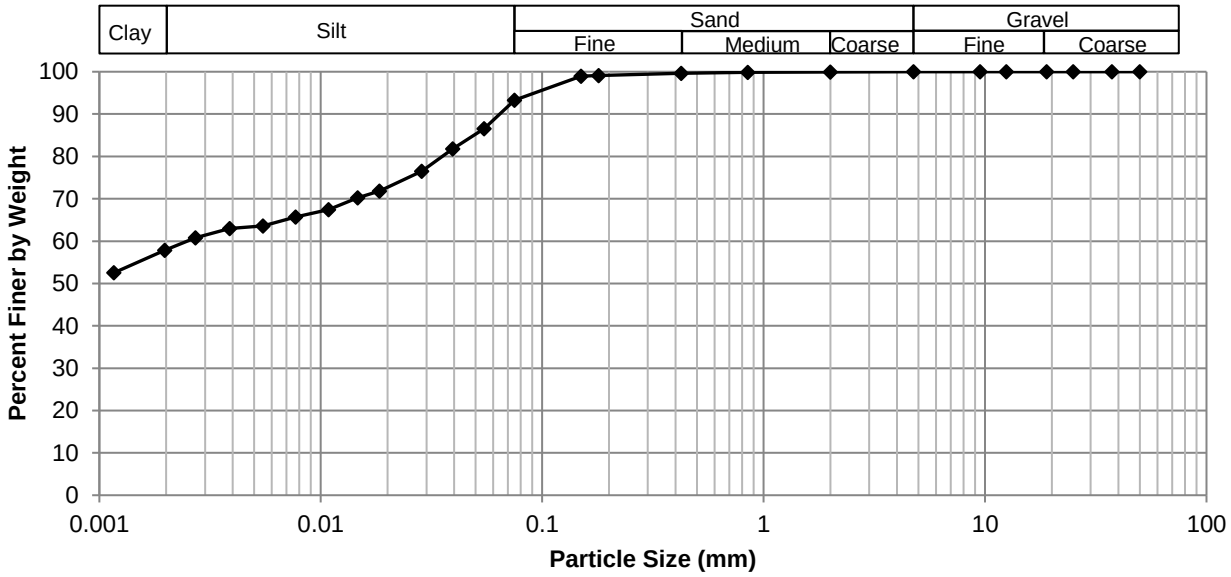
Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05- Spruce Clifton Alley
Test Hole	TH22-15
Sample #	G101
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.0%
Sand	6.7%
Silt	35.4%
Clay	57.9%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	93.30
37.5	100.00	2.00	99.94	0.0547	86.52
25.0	100.00	0.850	99.84	0.0395	81.84
19.0	100.00	0.425	99.66	0.0286	76.52
12.5	100.00	0.180	99.12	0.0185	71.84
9.50	100.00	0.150	98.96	0.0147	70.28
4.75	100.00	0.075	93.30	0.0108	67.46
				0.0077	65.71
				0.0055	63.59
				0.0039	63.02
				0.0027	60.77
				0.0020	57.83
				0.0012	52.52

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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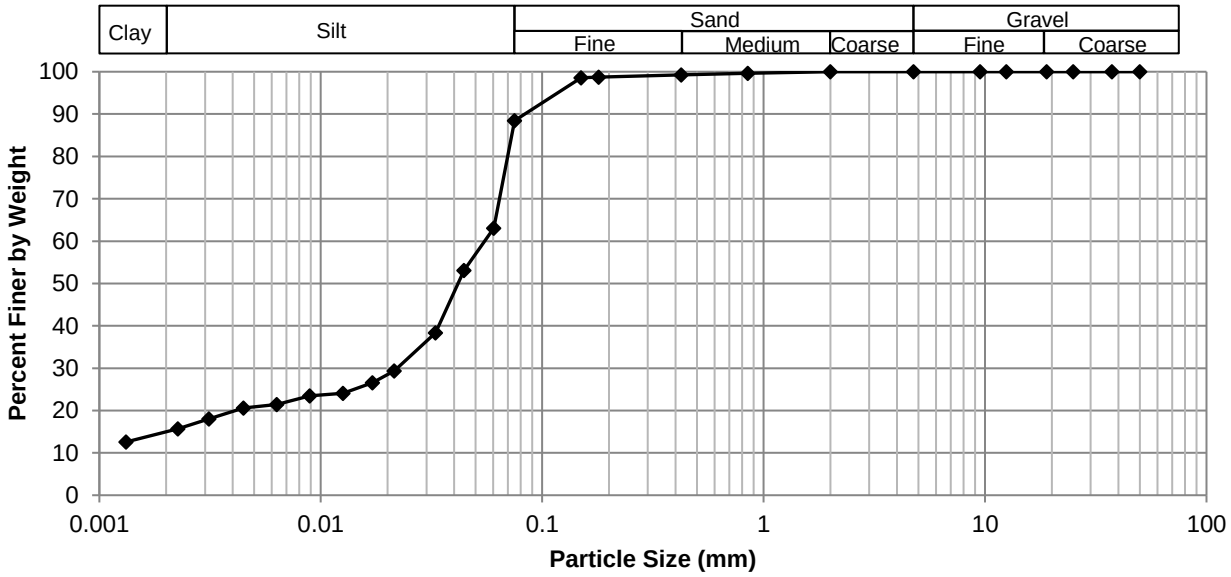
Project No.	1000-043-19
Client	WSP Canada Inc.
Project	Local Street Package 22-R-05-Spruce Clifton Alley
Test Hole	TH22-16
Sample #	G108
Depth (m)	0.9 - 1.1
Sample Date	7-Feb-22
Test Date	11-Feb-22
Technician	NM

Gravel	0.0%
Sand	11.5%
Silt	73.7%
Clay	14.8%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	88.47
37.5	100.00	2.00	100.00	0.0605	63.08
25.0	100.00	0.850	99.60	0.0444	53.07
19.0	100.00	0.425	99.23	0.0330	38.38
12.5	100.00	0.180	98.74	0.0215	29.37
9.50	100.00	0.150	98.58	0.0171	26.56
4.75	100.00	0.075	88.47	0.0126	24.06
				0.0089	23.50
				0.0063	21.44
				0.0045	20.57
				0.0031	18.00
				0.0023	15.69
				0.0013	12.57

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Standard Proctor Compaction Test

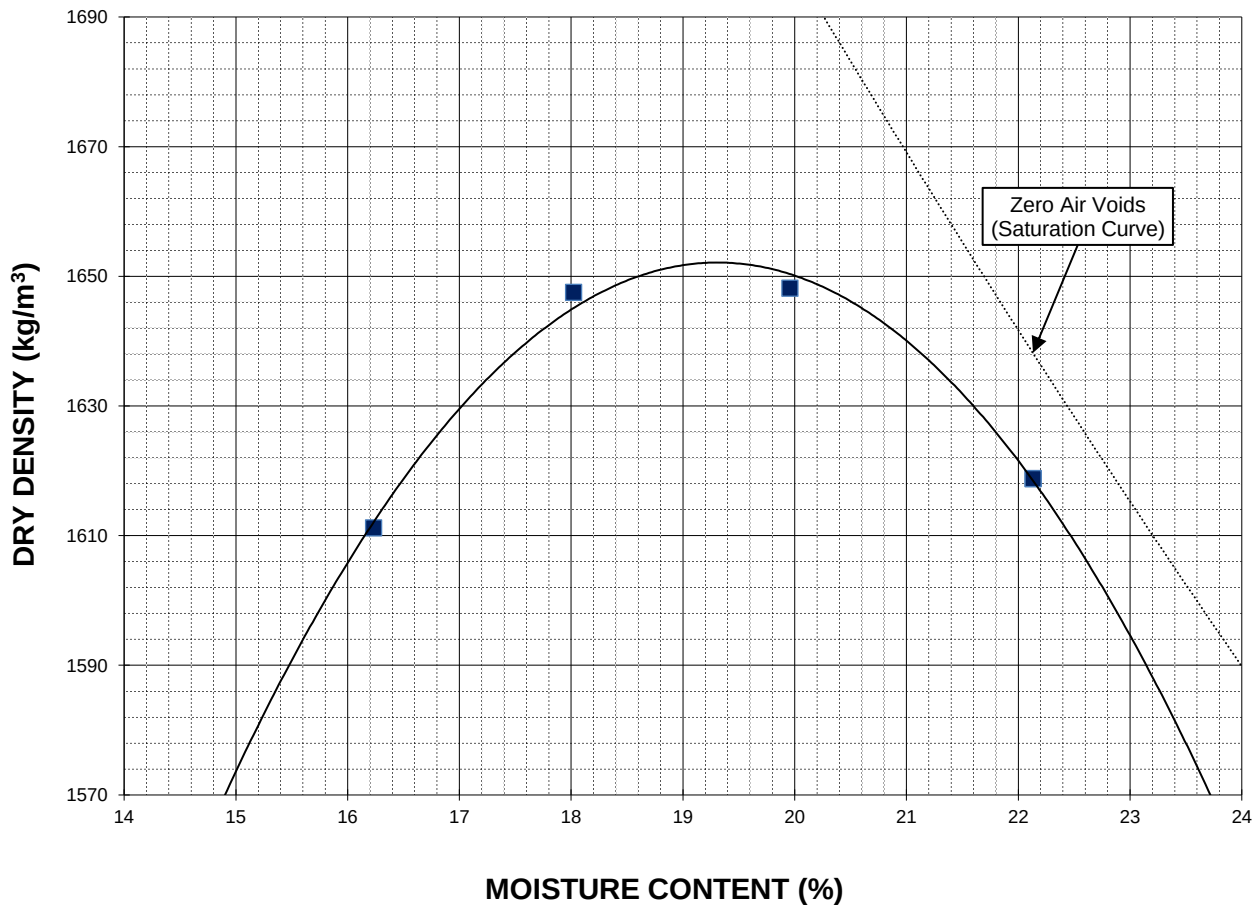
ASTM D698-12e2

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-19
Client	WSP
Project	2022 Local Streets Package
Sample #	Combined bulk samples
Source	TH22-13, 15 (Spruce Clifton Alley)
Material	Clay
Sample Date	07-Feb-22
Test Date	10-Feb-22
Technician	RS

Maximum Dry Density (kg/m3)	1652
Optimum Moisture (%)	19.3

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1873	1944	1977	1977	
Dry Density (kg/m^3)	1611	1648	1648	1619	
Moisture Content (%)	16.2	18.0	20.0	22.1	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-13, 15
Client	WSP	**Material**	Clay
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Spruce Clifton Alley)	**Test Date**	2022-02-12
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1652	kg/m3
Optimum Moisture Content	19.3	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1570	kg/m3
Initial Moisture Content	21.6	%
Relative Density	95.0	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.4	%
Moisture Content in top 25 mm	24.0	%
Immersion Period	96	h

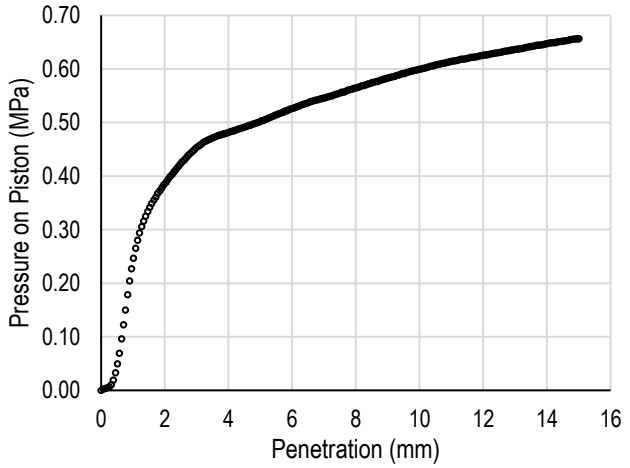
CBR Results

CBR at 2.54 mm	6.2	%
CBR at 5.08 mm	4.9	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.10	0.10
1.27	0.31	0.31
1.91	0.38	0.38
2.54	0.43	0.43
3.18	0.46	0.46
3.81	0.48	0.48
4.45	0.49	0.49
5.08	0.50	0.50
7.62	0.56	0.56
10.16	0.60	0.60
12.70	0.63	0.63

Load/Penetration Curve



Comments:

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Standard Proctor Compaction Test

ASTM D698-12e2

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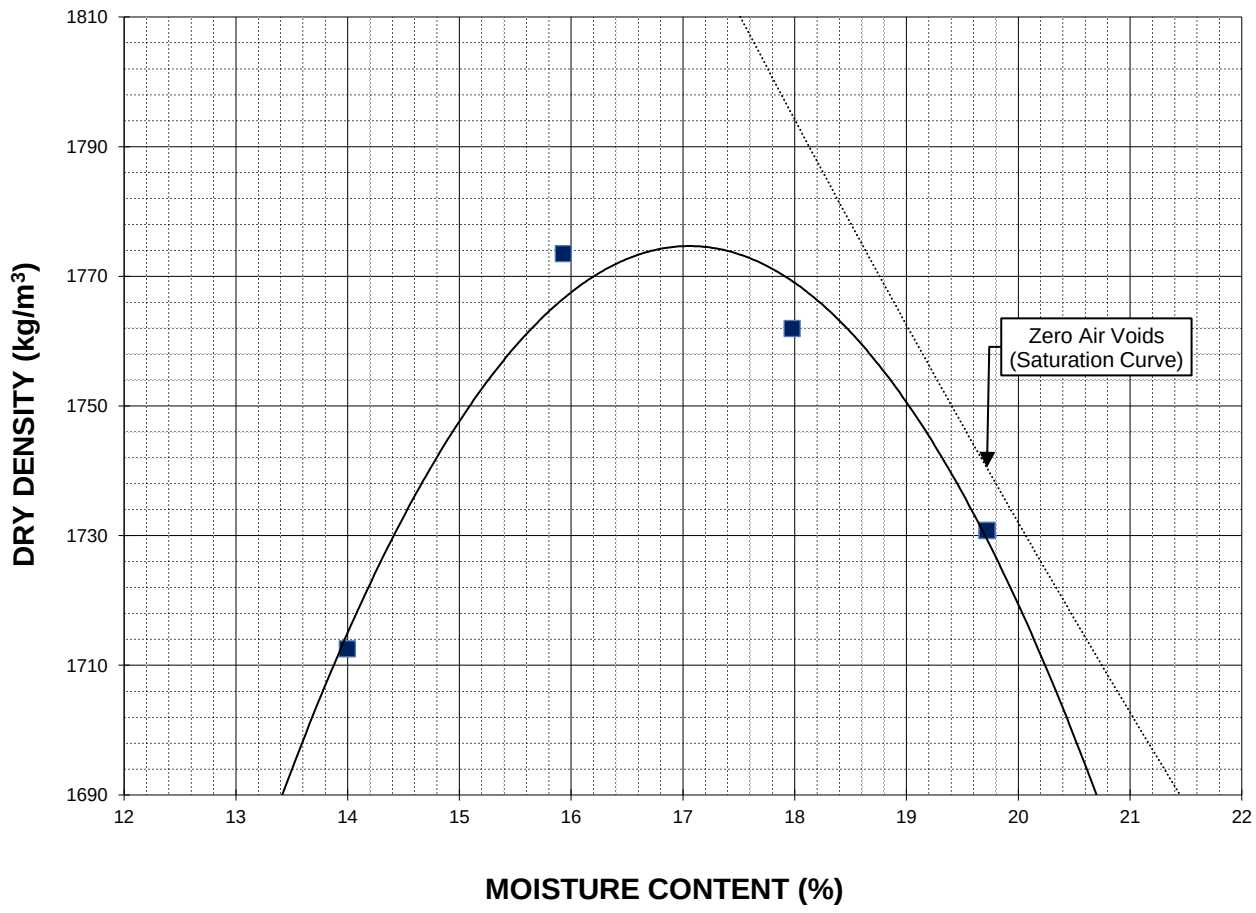
Project No.	1000-043-19
Client	WSP
Project	2022 Local Streets Package
Sample #	Combined bulk samples
Source	TH22-14, 16 (Spruce Clifton Alley)
Material	Silt
Sample Date	07-Feb-22
Test Date	10-Feb-22
Technician	RS

Maximum Dry Density (kg/m3)	1775
Optimum Moisture (%)	17.1

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1952	2056	2079	2072	
Dry Density (kg/m^3)	1713	1773	1762	1731	
Moisture Content (%)	14.0	15.9	18.0	19.7	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-19	**Source**	TH22-14, 16
Client	WSP	**Material**	Silt
Project	2022 Local Streets Package	**Sample Date**	2022-02-07
Sample #	Bulk (Spruce Clifton Alley)	**Test Date**	2022-02-14
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1775	kg/m3
Optimum Moisture Content	17.0	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1701	kg/m3
Initial Moisture Content	19.0	%
Relative Density	95.8	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.2	%
Moisture Content in top 25 mm	19.9	%
Immersion Period	96	h

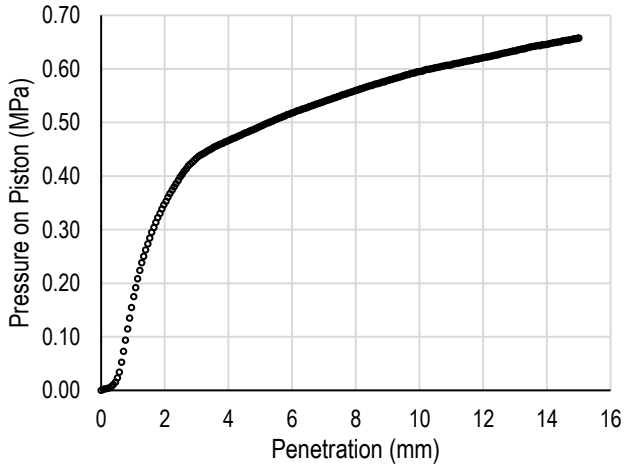
CBR Results

CBR at 2.54 mm	5.9	%
CBR at 5.08 mm	4.8	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.05	0.05
1.27	0.24	0.24
1.91	0.34	0.34
2.54	0.40	0.40
3.18	0.44	0.44
3.81	0.46	0.46
4.45	0.48	0.48
5.08	0.50	0.50
7.62	0.55	0.55
10.16	0.60	0.60
12.70	0.63	0.63

Load/Penetration Curve



Comments:

Photo 1: Pavement Core Sample at Test Hole TH22-13

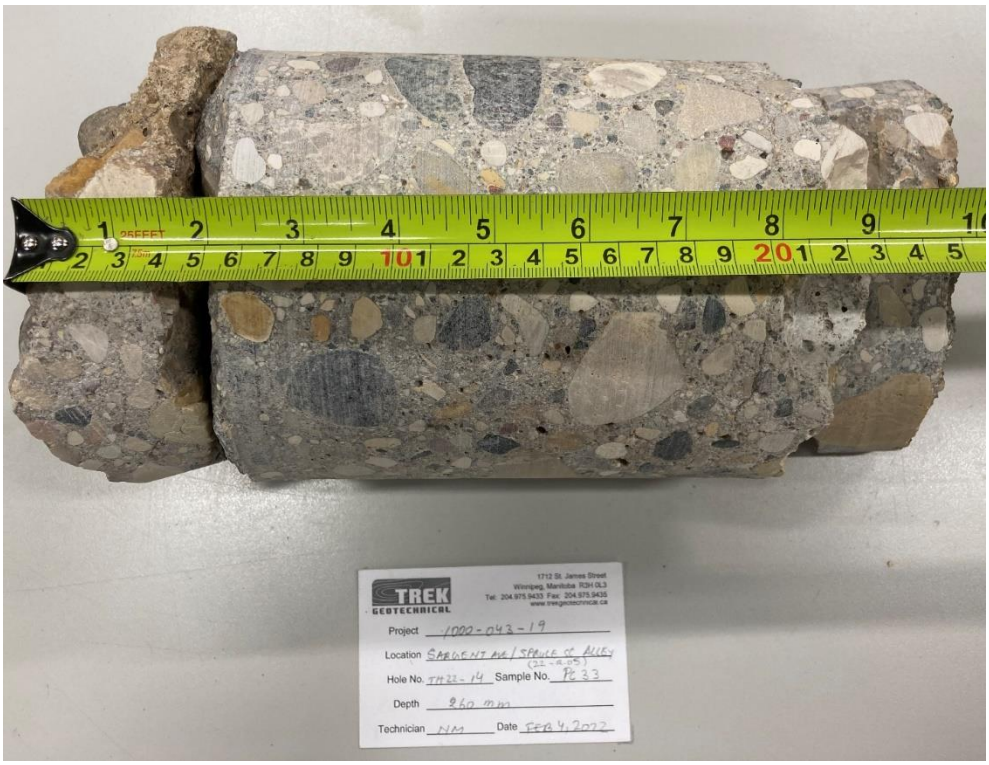


Photo 2: Pavement Core Sample at Test Hole TH22-14

Photo 3: Pavement Core Sample at Test Hole TH22-15

Photo 4: Pavement Core Sample at Test Hole TH22-16

Appendix E

Summary Table, Pavement Core Photos, and Summary of Pavement Compressive Strength – Forest Park Drive

2022 Local Street Package - 22-R-05

Forest Park Drive: between Airlies Street and Sinclair Street

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC22-01	UTM : 5534224 m N, 633285 m E; Located 23 m East of Airlies Street and Forest Park Drive intersection, Eastbound lane, 1.5 m North of South curb.	Asphalt	60	Concrete	110	61.29
PC22-02	UTM : 5534199 m N, 633303 m E; Located 26 m West of Sweetwood Bay and Forest Park Drive intersection, Westbound lane, 1.5 m South of North curb.	Asphalt	50	Concrete	150	-
PC22-03	UTM : 5534164 m N, 633337 m E; Located 23 m East of Sweetwood Bay and Forest Park Drive intersection, Eastbound lane, 1.5 m North of South curb.	Asphalt	50	Concrete	140	69.07
PC22-04	UTM : 5534140 m N, 633368 m E; Located 94 m West of Sinclair Street and Forest Park Drive intersection, Westbound lane, 1.5 m South of North curb.	Asphalt	50	Concrete	140	-
PC22-05	UTM : 5534095 m N, 633408 m E; Located 48 m West of Sinclair Street and Forest Park Drive intersection, Eastbound lane, 1.5 m North of South curb.	Asphalt	40	Concrete	160	66.00

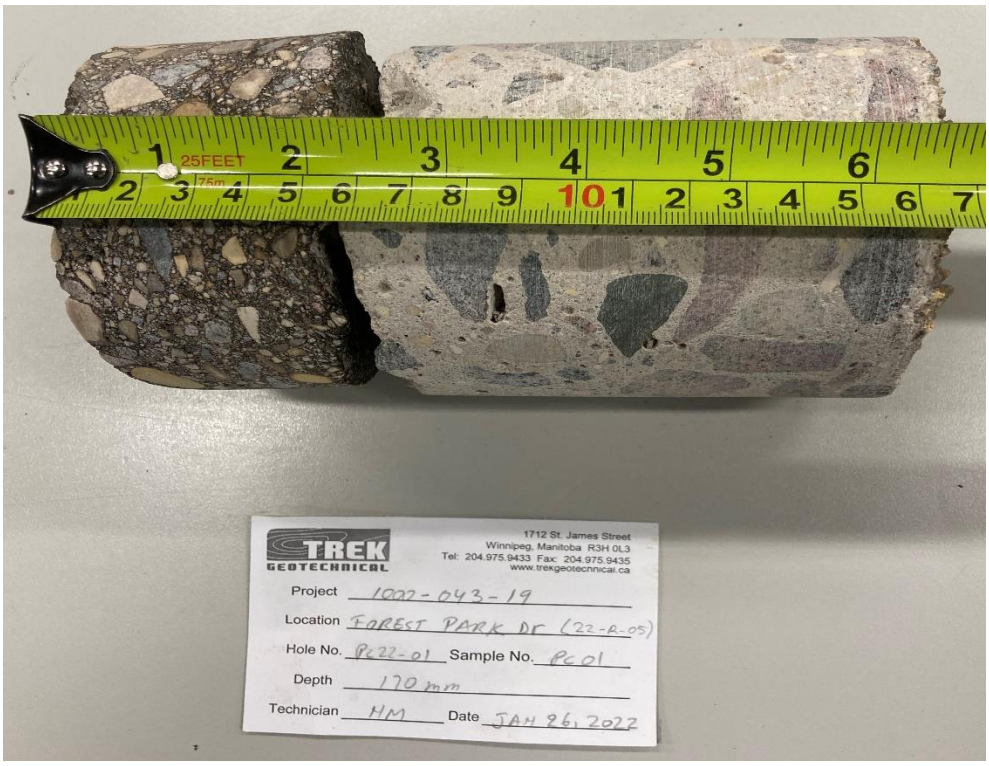


Photo 1: Pavement Core Sample at PC22-01

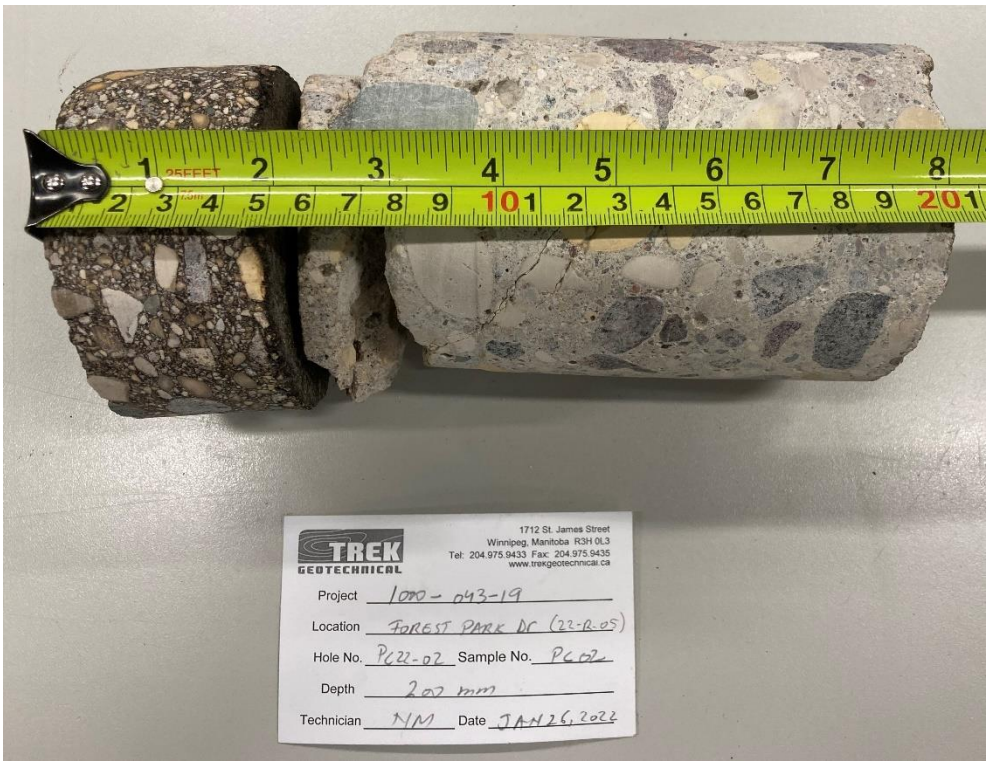


Photo 2: Pavement Core Sample at PC22-02

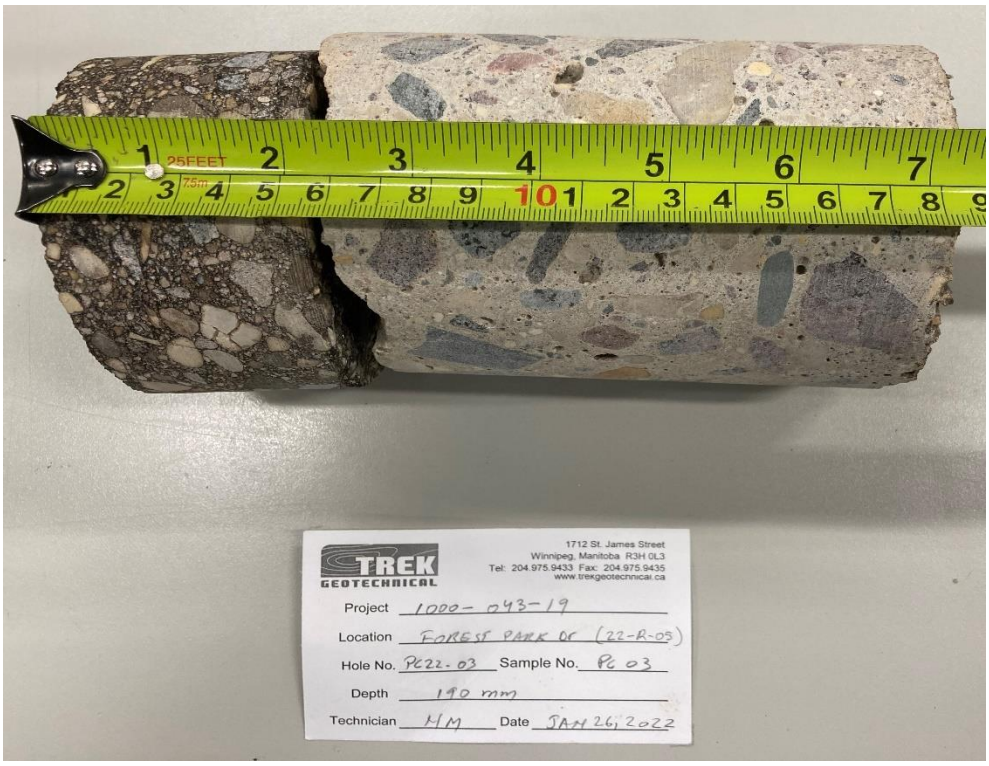


Photo 3: Pavement Core Sample at PC22-03

Photo 4: Pavement Core Sample at PC22-04

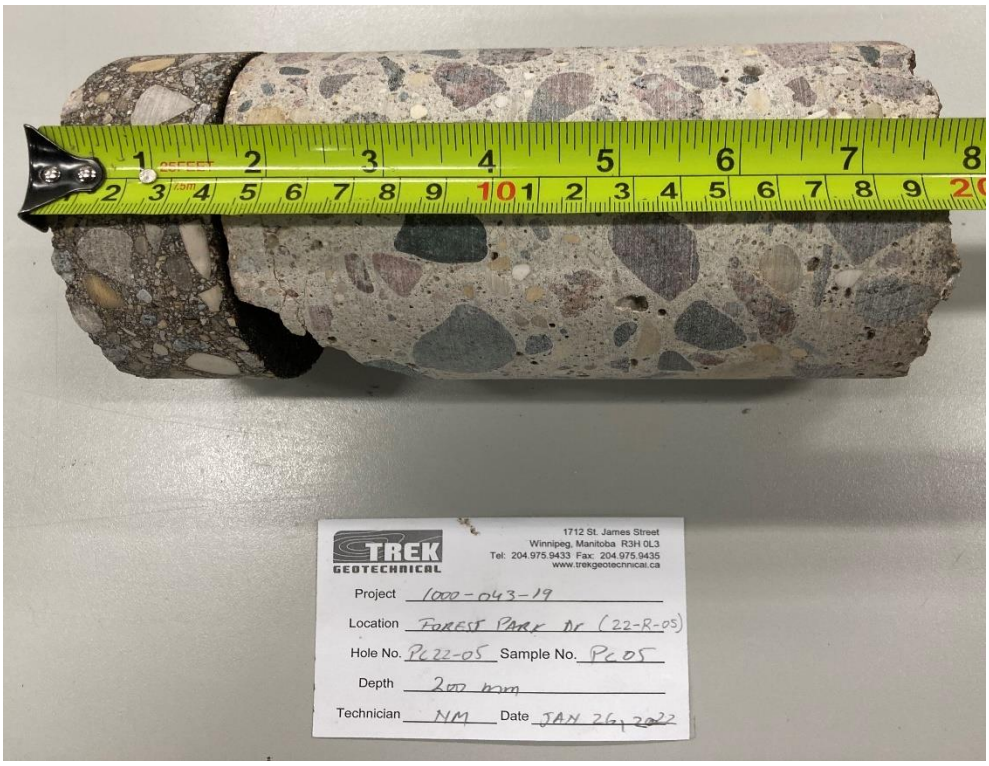


Photo 5: Pavement Core Sample at PC22-05

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Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-19 **Date** February 11, 2022

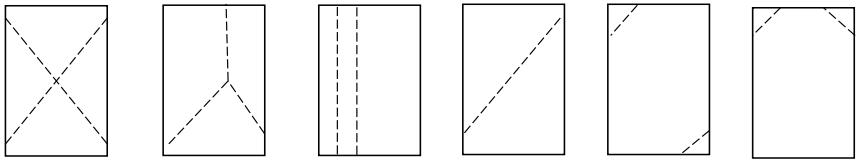
Project 2022 Local Street Package - 22-R-05 **Technician** NM

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Forest Park Drive	PC01	2022-01-26	2022-02-11	-	95	100	Soaked 48 h	57.59	61.29	1	0.92	1.00	1.09	1.06	1.00
Forest Park Drive	PC03	2022-01-26	2022-02-11	-	95	111	Soaked 48 h	63.47	69.07	1	0.94	1.00	1.09	1.06	1.00
Forest Park Drive	PC05	2022-01-26	2022-02-11	-	95	120	Soaked 48 h	59.85	66.00	2	0.95	1.00	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$



Type 1 Type 2 Type 3 Type 4 Type 5 Type 6

Reviewed by (print): Angela Fidler-Kliewer,C.Tech. Signature: Angela Fidler-Kliewer

Table 1 Factors involved in interpretation of core results by different codes.

List	Code/standard	Edition	Factors Considered					
			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
1	Egyptian Code/Standard Specification	2008	√		√			√
2	British Code/Standard Specification	2003	√		√			√
3	American Concrete Institute ACI	1998	√					
		2012	√	√		√	√	
4	European Standard Specification	1998	√	√	√		√	
		2009	√		√			
5	Japanese Standard	1998	√					
6	Concrete Society	1987	√		√		√	√

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of $(\Phi_r * d)$ is considered. If the bars are further apart, their combined effect should be assessed by replacing the term $(\Phi_r * d)$ by the term $(\sum \Phi_r * d)$.

It should be pointed out that above equations used to interpret the core concrete strength to the in-situ concrete cube strength have been developed based on a set of assumptions and through many converting process. It is also of interest to note that the damage effect is considered in the development of the formulas in indirect way. The subject derivation and detailed formulas may be seen elsewhere [14].

3.2. American Concrete Institute (ACI)

3.2.1. Former ACI Code (2002) & Current ASTM (2009)

The methodology of core interpretation given in the former ACI code was remained without changes for decades and up to Year (2003). The in-place strength of concrete cylinder at the location from which a core test specimen was extracted can be computed using the equation:

$$f_{cy} = F_{l/d} \cdot f_{core} \tag{4}$$

where f_{cy} is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, and $F_{l/d}$ is the strength correction factor for aspect ratio.

The former ACI code does not include any equation to calculate the correction factor ($F_{l/d}$); however, the code gives different values for this term that is associated with different aspect ratios (l/d) as given in Table 2. It should also be noted that the approach of current ASTM is similar to that mentioned above. The only considered variable is the aspect ratio (l/d). It should be noted that identical approach to that mentioned above is still effective in ASTM C42/C42M-03 [10].

3.2.2. Current ACI Code (2012) [15]

Starting from Year 2003, significant changes have been made to the relevant ACI Code provisions regarding the interpretation of core strength test results. New factors have been considered. These include core diameter, moisture content of core sample, core damage associated with drilling, in addition to the effect of aspect ratio that was previously considered in the former ACI edition (1998). According to the ACI 214.4R-03, the in-place concrete strength can be computed using the equation:

$$f_c = F_{l/d} \cdot F_{dia} \cdot F_{mc} \cdot F_D \cdot f_{core} \tag{5}$$

where f_c is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, $F_{l/d}$ is strength correction factor for aspect ratio, F_{dia} is strength correction factors for diameter, F_{mc} is strength correction factor for moisture condition of core sample, and F_D is the strength correction factor that accounts for effect of damage sustained during core drilling including micro-cracking and undulations at the drilled surface and cutting through coarse-aggregate particles that may subsequently pop out during testing.

The ACI committee considered the correction factors presented in Table 3 for converting core strengths into equivalent in-place strengths based on the work reported by Bartlett and MacGregor [6]. It should be noted that the magnitude of

Table 2 Mean values for factor $F_{l/d}$ according to ACI Code (1998) and ASTM.

	Specimen length-to-diameter ratio, l/d			
	1.00	1.25	1.50	1.75
$F_{l/d}$	0.87	0.93	0.96	0.98

Table 3 Strength correction factors according to ACI 214.4R-03.

List	Factors	Mean values
(1)[b]	$F_{l/d}$: l/d ratio	
	As-received	$1 - \{0.130 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Soaked 48 h	$1 - \{0.117 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Air dried[a]	$1 - \{0.144 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
	As-received	1.00
	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.
[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
A9																		
A10								■▲●										
A11																		
A12		●		●	●													
A13																		
A14		●		●														
A15		●																
A16	●♦																	
A17	♦																	
A18																		

● Diameter of steel bar.
▲ Distance of steel bar from nearly end of core.
■ Number of steel bars and spacing between bars.
♦ Distance of steel bar from vertical axis of specimen.

This brief review indicated that the various proposed relationships for correction factors are all nonlinear. It should be noted that the equations given by the Egyptian Code takes into account most variables that may affect the interpretation of the results; however, the code ignores the deterioration of steel–concrete bond that may occur and also the position of the reinforcement from vertical axis of core specimens.

Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

- For cores containing a single bar:

$$F_{reinf} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{core}^{0.015}} \quad (12)$$

- For core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect is assessed by replacing the term ($\Phi_r * r$) by ($\sum \Phi_r * r$ as follows:

$$F_{reinf} = \left[1 + 1.5\frac{\sum[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{core}^{0.015}} \quad (13)$$

where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

6.1.6. *Effect of moisture condition of core*

Results of about 100 cores indicate that the strength of cores left to dry in air for 7 days is on average 13% greater than that of cores soaked at least 40 h before testing. The strength of cores with negligible moisture gradient and tested after cutting is found to be 7–9% larger than that of soaked cores as shown in Fig. 20. The authors strongly recommend to use a correction factor accounting for moisture condition (F_m) equals to 1.09 and 0.96, respectively, for cores tested after 48 h soaked in water and for those tested after 7 days dry in air.

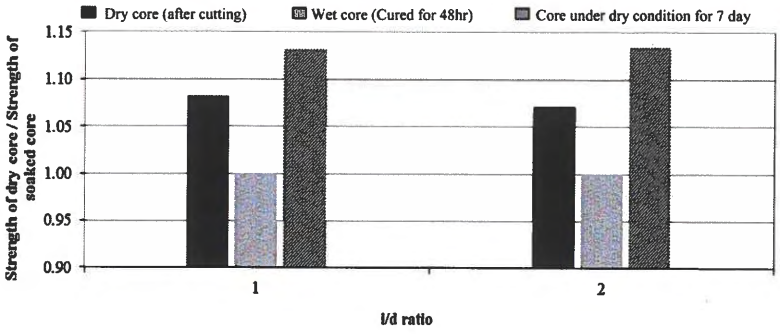


Figure 20 Effect of core moisture condition on core strength for different aspect ratios (l/d).

Appendix F

Summary Table, Pavement Core Photos, and Summary of Pavement Compressive Strength – Grundy Avenue

2022 Local Street Package - 22-R-05

Grundy Avenue: between Ingersoll Street and Garfield Street North

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC22-18	UTM : 5529555 m N, 631110 m E; Located 30 m East of Sherburn Street and Grundy Avenue intersection, Westbound lane, 1.5 m South of North curb.	Asphalt	-	Concrete	170	52.49
PC22-19	UTM : 5529554 m N, 631031 m E; Located 34 m East of Garfield Street and Grundy Avenue intersection, Eastbound lane, 1.5 m North of South curb.	Asphalt	-	Concrete	170	67.60
PC22-36	UTM : 5529552 m N, 631132 m E; Located 30 m West of Ingersoll Street and Grundy Avenue intersection, Eastbound lane, 1.5 m North of South curb.	Asphalt	-	Concrete	150	-

Photo 1: Pavement Core Sample at PC22-18

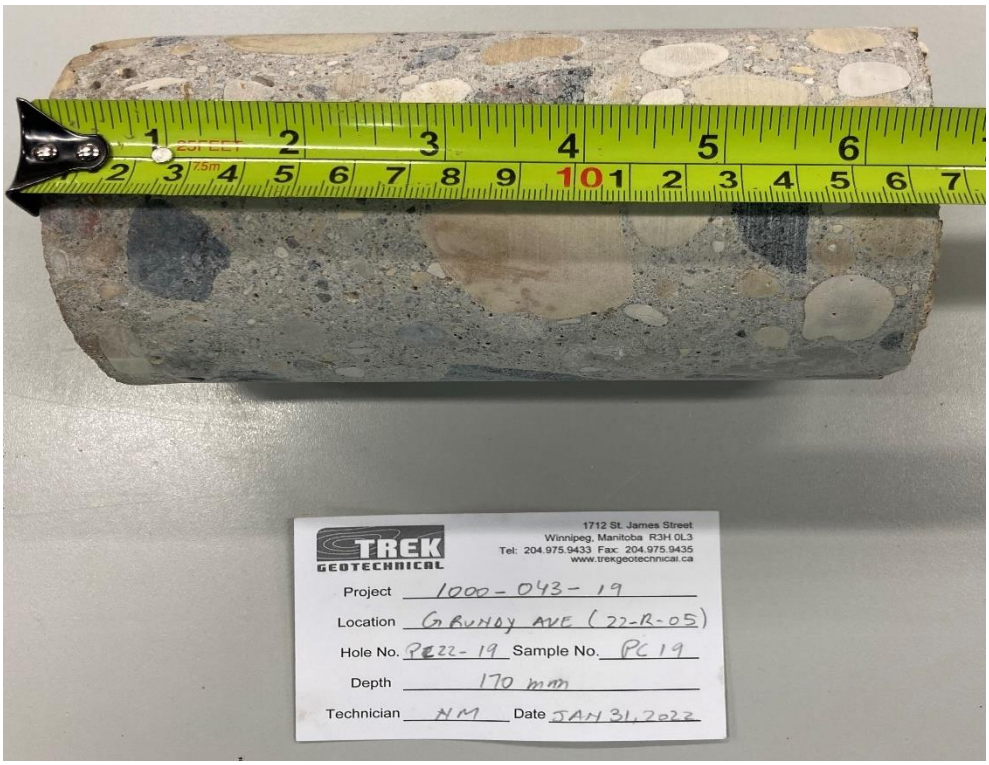


Photo 2: Pavement Core Sample at PC22-19

Photo 3: Pavement Core Sample at PC22-36

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Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-19 **Date** February 11, 2022

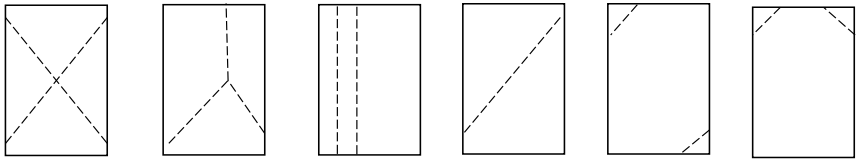
Project 2022 Local Street Package - 22-R-05 **Technician** NM

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Grundy Avenue	PC18	2022-01-31	2022-02-11	-	95	153	Soaked 48 h	45.92	52.49	1	0.99	1.00	1.09	1.06	1.00
Grundy Avenue	PC19	2022-01-31	2022-02-11	-	95	156	Soaked 48 h	58.95	67.60	1	0.99	1.00	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$



Type 1 Type 2 Type 3 Type 4 Type 5 Type 6

Reviewed by (print): Angela Fidler-Kliewer,C.Tech. Signature: Angela Fidler-Kliewer

Table 1 Factors involved in interpretation of core results by different codes.

List	Code/standard	Edition	Factors Considered					
			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
1	Egyptian Code/Standard Specification	2008	√		√			√
2	British Code/Standard Specification	2003	√		√			√
3	American Concrete Institute ACI	1998	√					
		2012	√	√		√	√	
4	European Standard Specification	1998	√	√	√		√	
		2009	√		√			
5	Japanese Standard	1998	√					
6	Concrete Society	1987	√		√		√	√

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of $(\Phi_r * d)$ is considered. If the bars are further apart, their combined effect should be assessed by replacing the term $(\Phi_r * d)$ by the term $(\sum \Phi_r * d)$.

It should be pointed out that above equations used to interpret the core concrete strength to the in-situ concrete cube strength have been developed based on a set of assumptions and through many converting process. It is also of interest to note that the damage effect is considered in the development of the formulas in indirect way. The subject derivation and detailed formulas may be seen elsewhere [14].

3.2. American Concrete Institute (ACI)

3.2.1. Former ACI Code (2002) & Current ASTM (2009)

The methodology of core interpretation given in the former ACI code was remained without changes for decades and up to Year (2003). The in-place strength of concrete cylinder at the location from which a core test specimen was extracted can be computed using the equation:

$$f_{cy} = F_{l/d} \cdot f_{core} \tag{4}$$

where f_{cy} is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, and $F_{l/d}$ is the strength correction factor for aspect ratio.

The former ACI code does not include any equation to calculate the correction factor ($F_{l/d}$); however, the code gives different values for this term that is associated with different aspect ratios (l/d) as given in Table 2. It should also be noted that the approach of current ASTM is similar to that mentioned above. The only considered variable is the aspect ratio (l/d). It should be noted that identical approach to that mentioned above is still effective in ASTM C42/C42M-03 [10].

3.2.2. Current ACI Code (2012) [15]

Starting from Year 2003, significant changes have been made to the relevant ACI Code provisions regarding the interpretation of core strength test results. New factors have been considered. These include core diameter, moisture content of core sample, core damage associated with drilling, in addition to the effect of aspect ratio that was previously considered in the former ACI edition (1998). According to the ACI 214.4R-03, the in-place concrete strength can be computed using the equation:

$$f_c = F_{l/d} \cdot F_{dia} \cdot F_{mc} \cdot F_D \cdot f_{core} \tag{5}$$

where f_c is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, $F_{l/d}$ is strength correction factor for aspect ratio, F_{dia} is strength correction factors for diameter, F_{mc} is strength correction factor for moisture condition of core sample, and F_D is the strength correction factor that accounts for effect of damage sustained during core drilling including micro-cracking and undulations at the drilled surface and cutting through coarse-aggregate particles that may subsequently pop out during testing.

The ACI committee considered the correction factors presented in Table 3 for converting core strengths into equivalent in-place strengths based on the work reported by Bartlett and MacGregor [6]. It should be noted that the magnitude of

Table 2 Mean values for factor $F_{l/d}$ according to ACI Code (1998) and ASTM.

	Specimen length-to-diameter ratio, l/d			
	1.00	1.25	1.50	1.75
$F_{l/d}$	0.87	0.93	0.96	0.98

Table 3 Strength correction factors according to ACI 214.4R-03.

List	Factors	Mean values
(1)[b]	$F_{l/d}$: l/d ratio	
	As-received	$1 - \{0.130 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Soaked 48 h	$1 - \{0.117 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Air dried[a]	$1 - \{0.144 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
	As-received	1.00
	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.
[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
A9																		
A10								■▲●										
A11																		
A12		●		●	●													
A13																		
A14		●		●														
A15		●																
A16	●♦																	
A17	♦																	
A18																		

● Diameter of steel bar.
▲ Distance of steel bar from nearly end of core.
■ Number of steel bars and spacing between bars.
♦ Distance of steel bar from vertical axis of specimen.

This brief review indicated that the various proposed relationships for correction factors are all nonlinear. It should be noted that the equations given by the Egyptian Code takes into account most variables that may affect the interpretation of the results; however, the code ignores the deterioration of steel–concrete bond that may occur and also the position of the reinforcement from vertical axis of core specimens.

Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

- For cores containing a single bar:

$$F_{reinf} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{core}^{0.015}} \quad (12)$$

- For core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect is assessed by replacing the term ($\Phi_r * r$) by ($\sum \Phi_r * r$ as follows:

$$F_{reinf} = \left[1 + 1.5\frac{\sum[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{core}^{0.015}} \quad (13)$$

where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

6.1.6. *Effect of moisture condition of core*

Results of about 100 cores indicate that the strength of cores left to dry in air for 7 days is on average 13% greater than that of cores soaked at least 40 h before testing. The strength of cores with negligible moisture gradient and tested after cutting is found to be 7–9% larger than that of soaked cores as shown in Fig. 20. The authors strongly recommend to use a correction factor accounting for moisture condition (F_m) equals to 1.09 and 0.96, respectively, for cores tested after 48 h soaked in water and for those tested after 7 days dry in air.

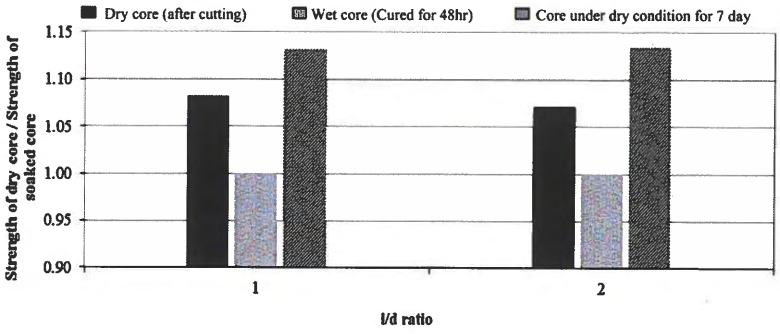


Figure 20 Effect of core moisture condition on core strength for different aspect ratios (l/d).

Appendix G

Summary Table, and Pavement Core Photos – Hume Street/Kairistine Lane Alley

2022 Local Street Package - 22-R-05

Hume Street and Kairistine Lane Alley: between Raber Road and Dexter Street

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC22-06	UTM : 5533635 m N, 629037 m E; Located behind #3 Hume Street, 2 m West of East edge of alley.	Asphalt	110	Concrete	-	-
PC22-07	UTM : 5533706 m N, 629033 m E; Located behind #27 Hume Street, 2 m West of East edge of alley.	Asphalt	110	Concrete	-	-
PC22-08	UTM : 5533749 m N, 629033 m E; Located behind #39 Hume Street, 2 m East of West edge of alley.	Asphalt	90	Concrete	-	-
PC22-09	UTM : 5533810 m N, 629031 m E; Located behind #59 Hume Street, 2.5 m West of East edge of alley.	Asphalt	110	Concrete	-	-
PC22-10	UTM : 5533655 m N, 629060 m E; Located behind #17 Raber Road, 2 m South of North edge of alley.	Asphalt	110	Concrete	-	-
PC22-11	UTM : 5533656 m N, 629090 m E; Located behind #5 Raber Road, 1.5 m North of South edge of alley.	Asphalt	100	Concrete	-	-

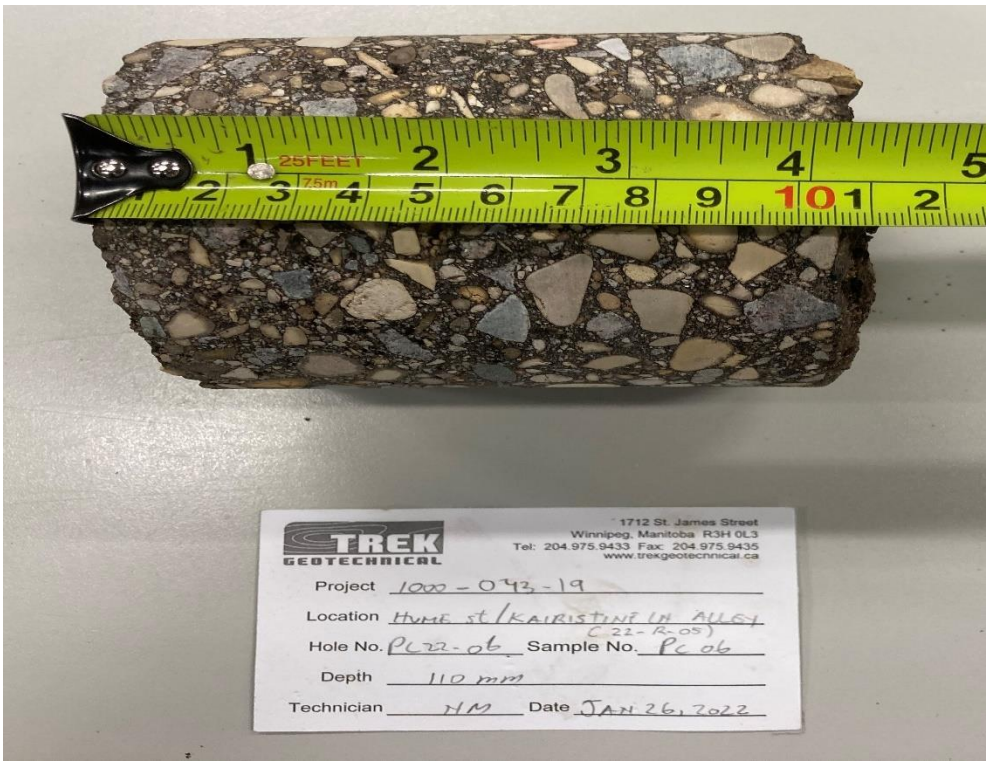


Photo 1: Pavement Core Sample at PC22-06

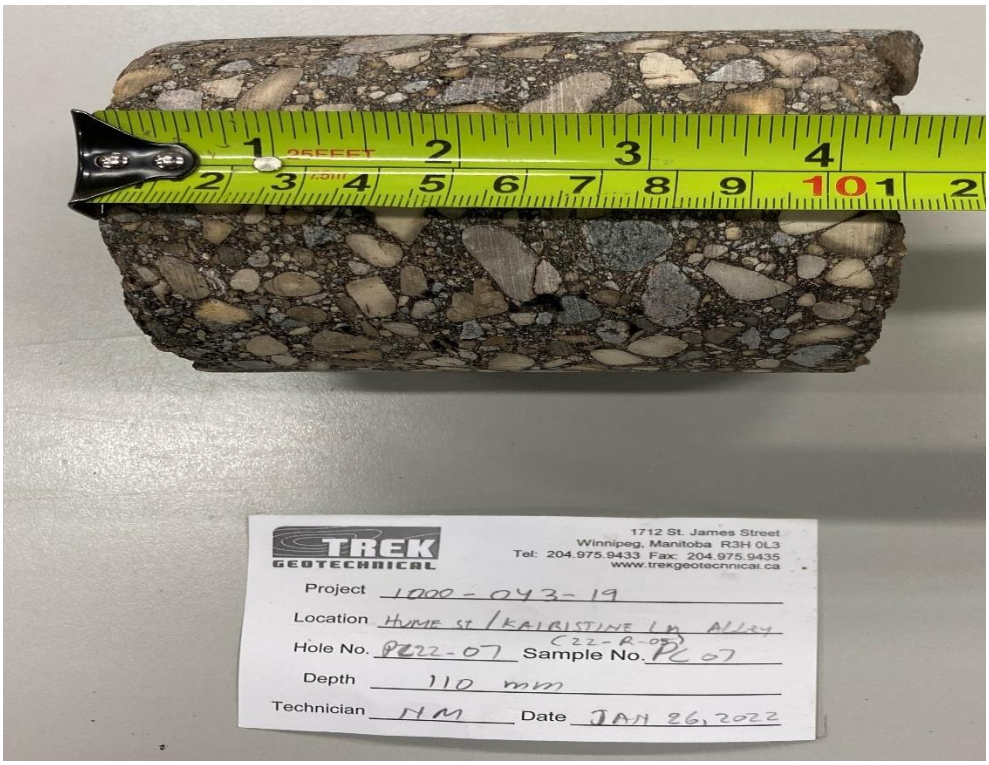


Photo 2: Pavement Core Sample at PC22-07

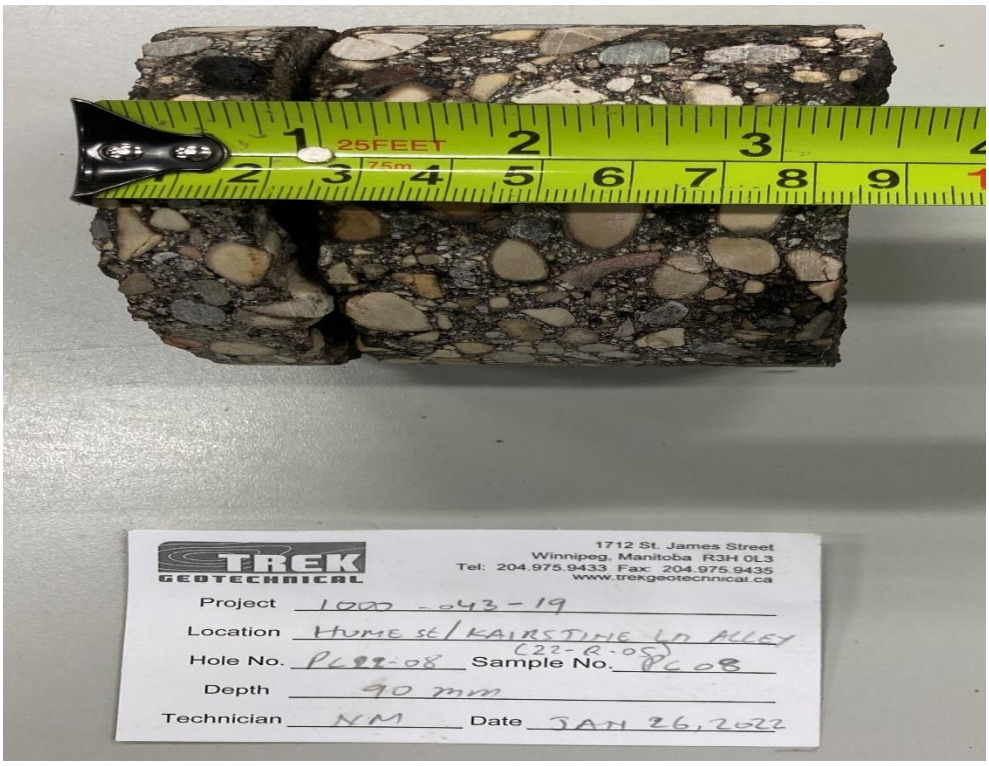


Photo 3: Pavement Core Sample at PC22-08

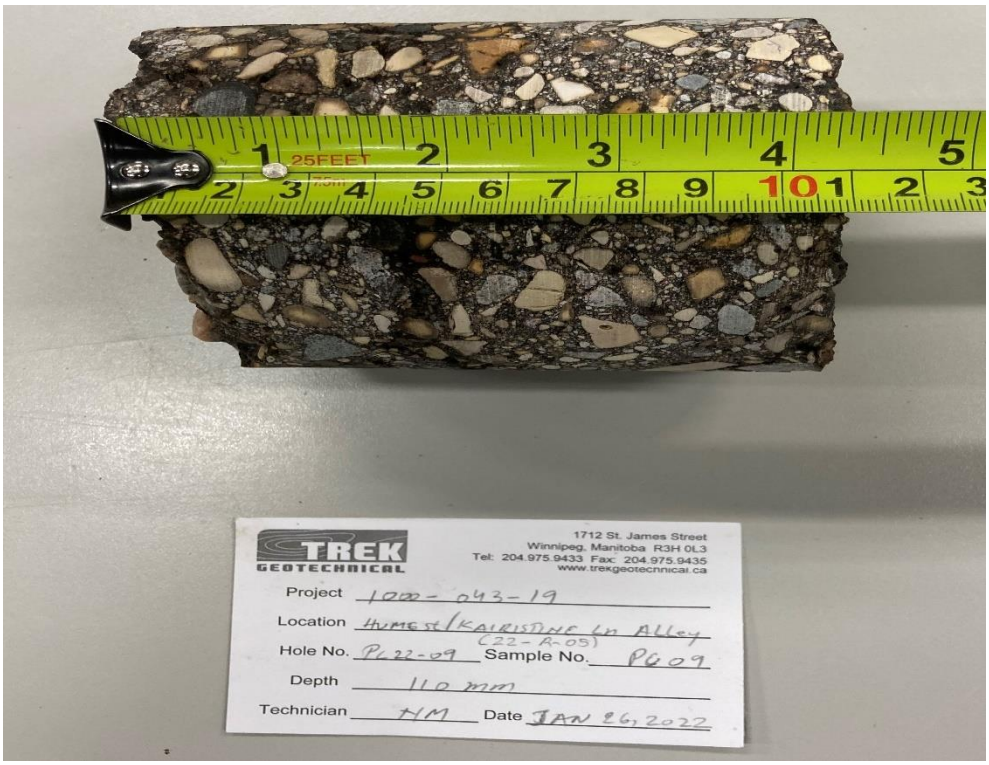


Photo 4: Pavement Core Sample at PC22-09

Photo 5: Pavement Core Sample at PC22-10

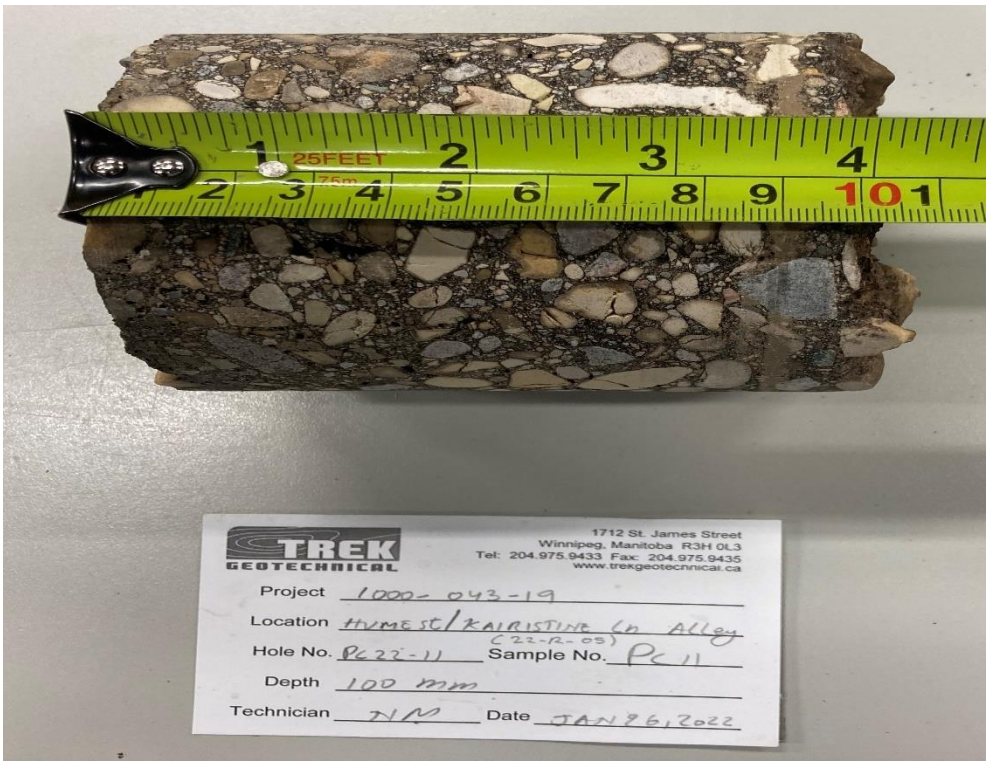


Photo 6: Pavement Core Sample at PC22-11

Appendix H

Summary Table, Pavement Core Photos, and Summary of Pavement Compressive Strength – Telfer Street N.

2022 Local Street Package - 22-R-05

Telfer Street North: between St Matthews Avenue and Ellice Avenue

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC22-12	UTM : 5528086 m N, 630235 m E; Located 36 m North of St Matthews Avenue and Telfer Street North intersection, Northbound lane, 1.5 m West of East curb.	Asphalt	-	Concrete	180	73.99
PC22-13	UTM : 5528155 m N, 630234 m E; Located 111 m North of St Matthews Avenue and Telfer Street North intersection, Southbound lane, 1.5 m East of West curb.	Asphalt	-	Concrete	160	-
PC22-14	UTM : 5528195 m N, 630237 m E; Located 160 m North of St Matthews Avenue and Telfer Street North intersection, Northbound lane, 1.5 m West of East curb.	Asphalt	-	Concrete	190	70.17
PC22-15	UTM : 5528259 m N, 630237 m E; Located 260 m North of St Matthews Avenue and Telfer Street North intersection, Southbound lane, 1.5 m East of West curb.	Asphalt	-	Concrete	190	74.80
PC22-16	UTM : 5528303 m N, 630239 m E; Located 100 m South of Ellice Avenue and Telfer Street North intersection, Northbound lane, 1.5 m West of East curb.	Asphalt	-	Concrete	160	-
PC22-17	UTM : 5528364 m N, 630240 m E; Located 35 m South of Ellice Avenue and Telfer Street North intersection, Southbound lane, 1.5 m East of West curb.	Asphalt	-	Concrete	180	-

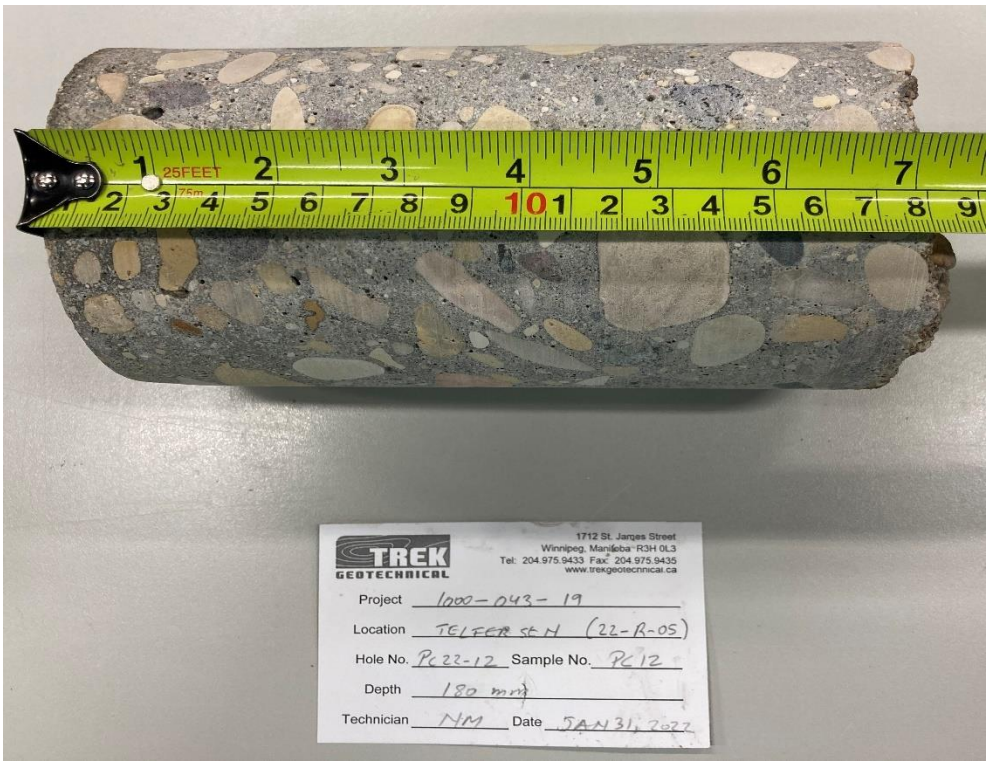


Photo 1: Pavement Core Sample at PC22-12

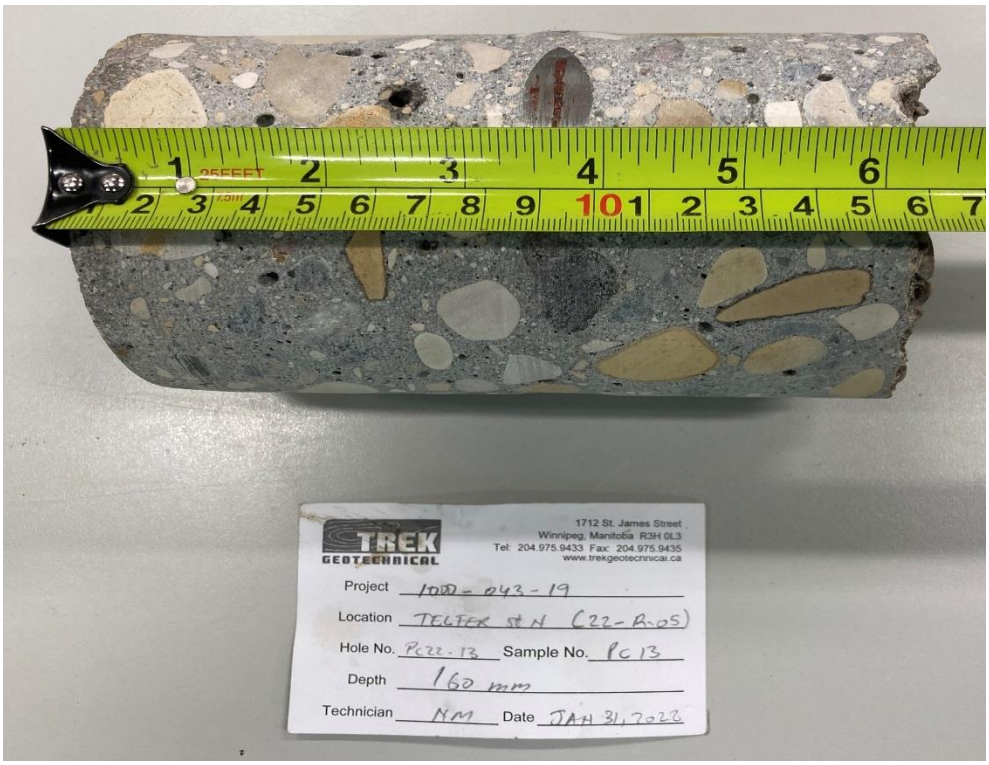


Photo 2: Pavement Core Sample at PC22-13

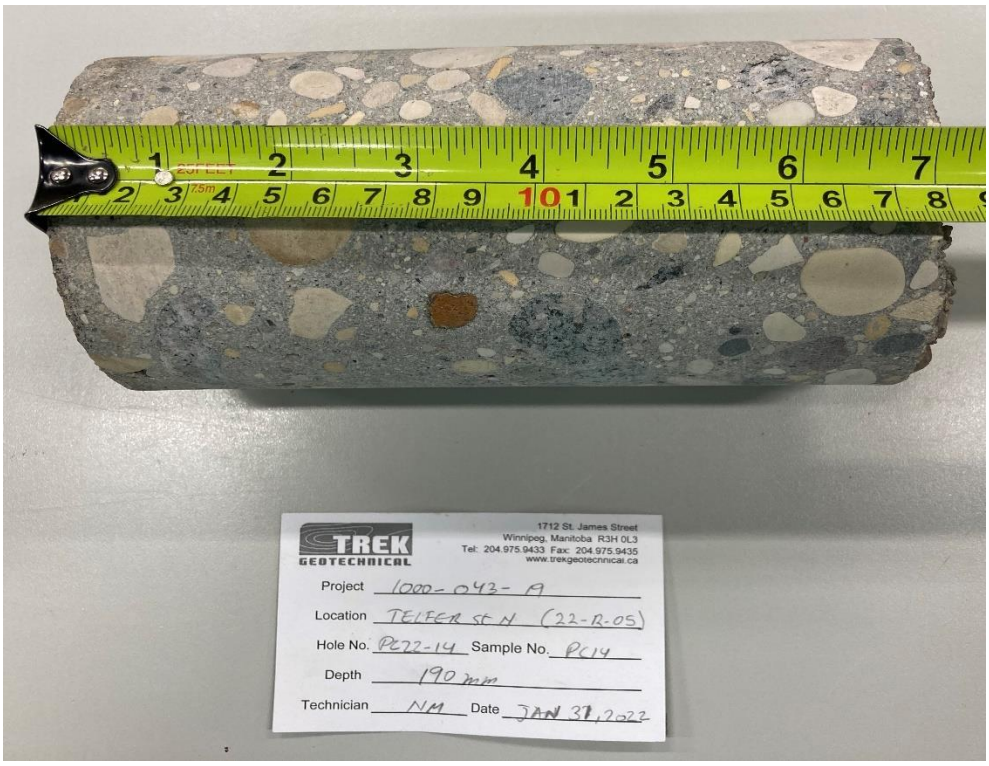


Photo 3: Pavement Core Sample at PC22-14

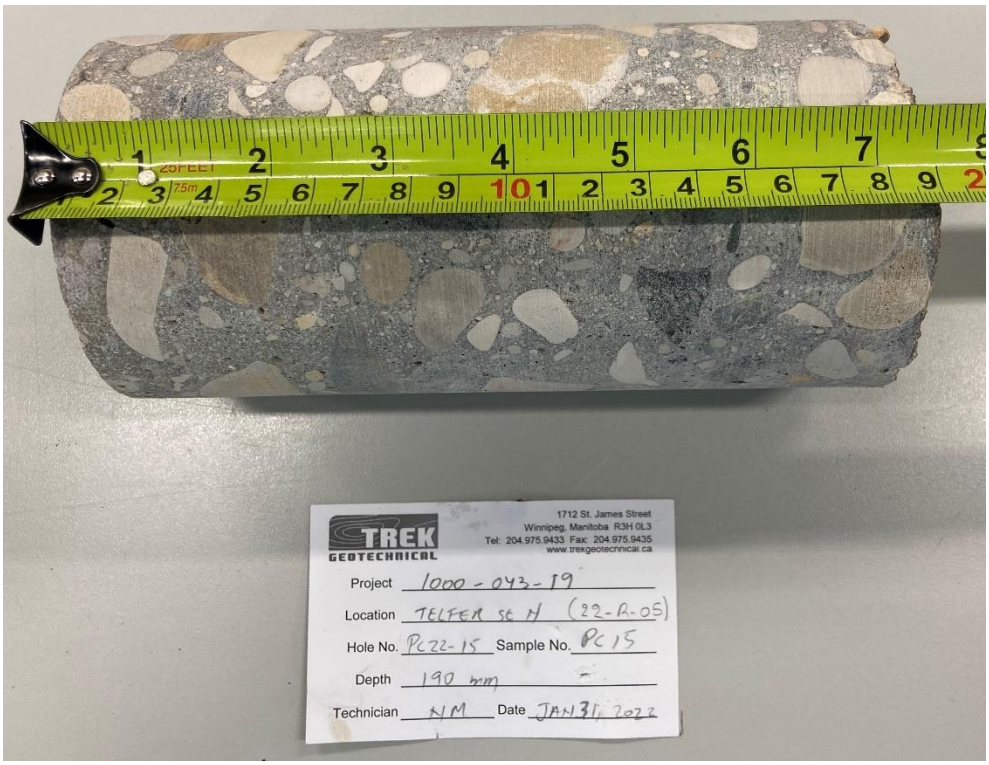


Photo 4: Pavement Core Sample at PC22-15

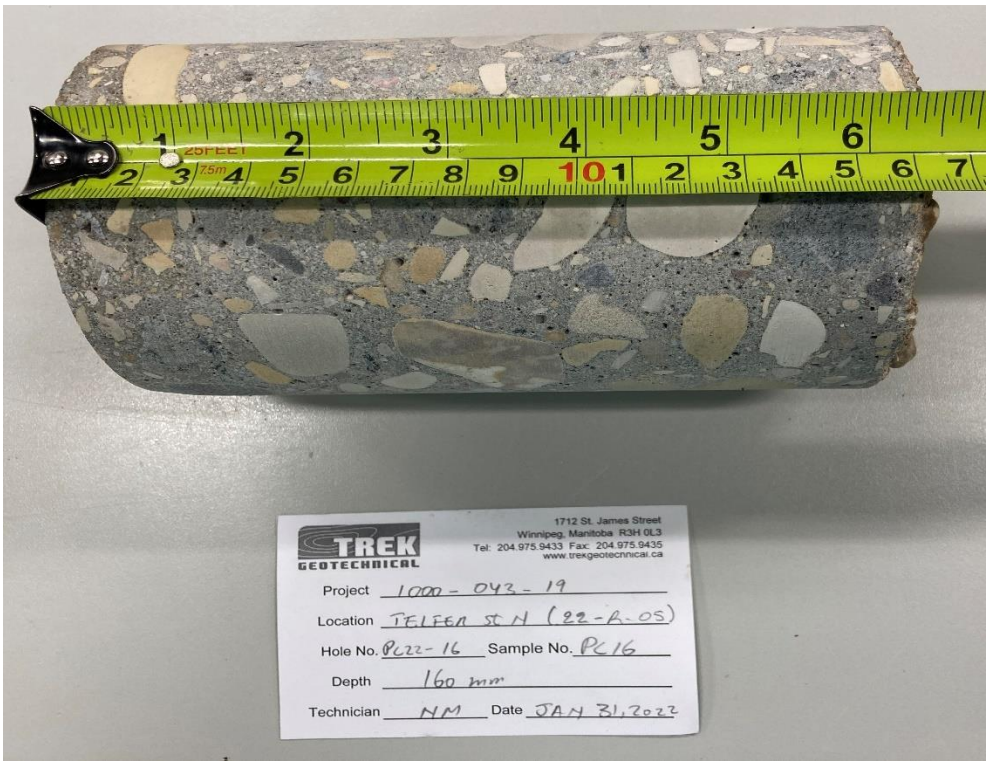


Photo 5: Pavement Core Sample at PC22-16

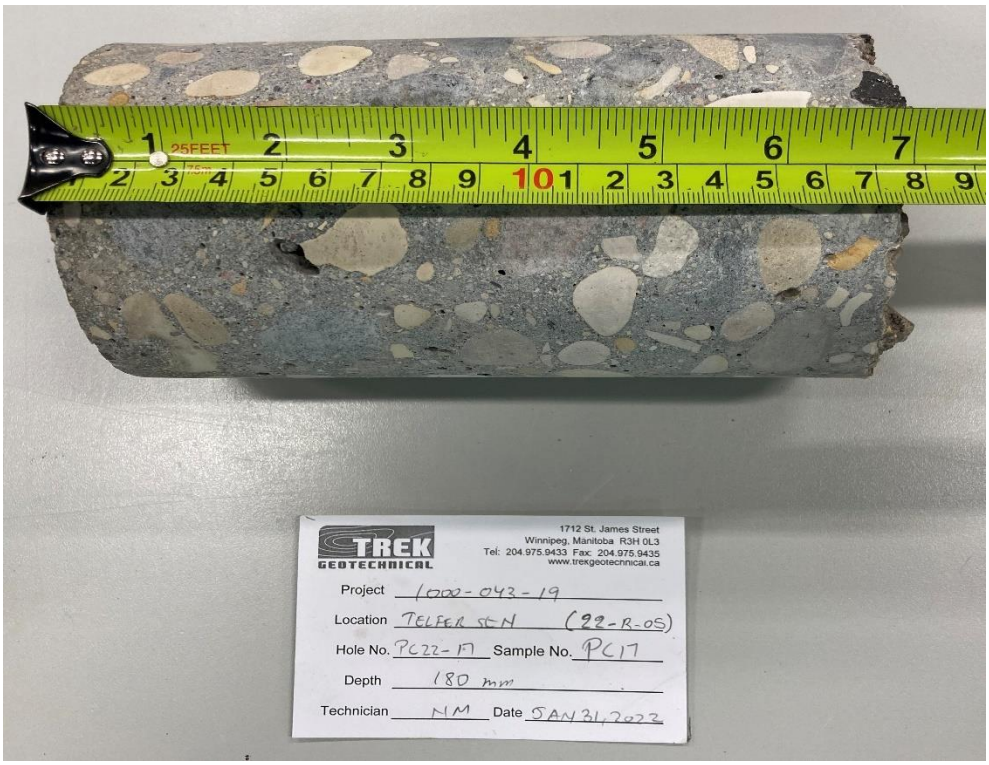


Photo 6: Pavement Core Sample at PC22-17

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1712 St. James Street
Winnipeg, MB R3H 0L3
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Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-19 **Date** February 11, 2022

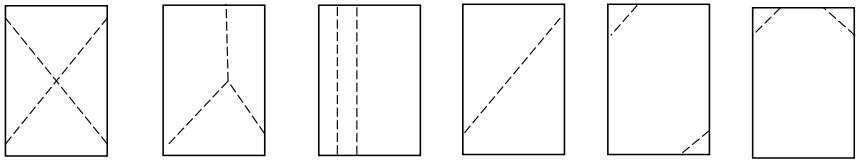
Project 2022 Local Street Package - 22-R-05 **Technician** NM

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Telfer Street North	PC12	2022-01-31	2022-02-11	-	95	155	Soaked 48 h	64.55	73.99	1	0.99	1.00	1.09	1.06	1.00
Telfer Street North	PC14	2022-01-31	2022-02-11	-	95	171	Soaked 48 h	60.70	70.17	1	1.00	1.00	1.09	1.06	1.00
Telfer Street North	PC15	2022-01-31	2022-02-11	-	95	173	Soaked 48 h	64.65	74.80	1	1.00	1.00	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$



Type 1 Type 2 Type 3 Type 4 Type 5 Type 6

Reviewed by (print): Angela Fidler-Kliewer C.Tech. Signature: Angela Fidler-Kliewer

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			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
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2	British Code/Standard Specification	2003	√		√			√
3	American Concrete Institute ACI	1998	√					
		2012	√	√		√	√	
4	European Standard Specification	1998	√	√	√		√	
		2009	√		√			
5	Japanese Standard	1998	√					
6	Concrete Society	1987	√		√		√	√

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of $(\Phi_r * d)$ is considered. If the bars are further apart, their combined effect should be assessed by replacing the term $(\Phi_r * d)$ by the term $(\sum \Phi_r * d)$.

It should be pointed out that above equations used to interpret the core concrete strength to the in-situ concrete cube strength have been developed based on a set of assumptions and through many converting process. It is also of interest to note that the damage effect is considered in the development of the formulas in indirect way. The subject derivation and detailed formulas may be seen elsewhere [14].

3.2. American Concrete Institute (ACI)

3.2.1. Former ACI Code (2002) & Current ASTM (2009)

The methodology of core interpretation given in the former ACI code was remained without changes for decades and up to Year (2003). The in-place strength of concrete cylinder at the location from which a core test specimen was extracted can be computed using the equation:

$$f_{cy} = F_{l/d} \cdot f_{core} \tag{4}$$

where f_{cy} is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, and $F_{l/d}$ is the strength correction factor for aspect ratio.

The former ACI code does not include any equation to calculate the correction factor ($F_{l/d}$); however, the code gives different values for this term that is associated with different aspect ratios (l/d) as given in Table 2. It should also be noted that the approach of current ASTM is similar to that mentioned above. The only considered variable is the aspect ratio (l/d). It should be noted that identical approach to that mentioned above is still effective in ASTM C42/C42M-03 [10].

3.2.2. Current ACI Code (2012) [15]

Starting from Year 2003, significant changes have been made to the relevant ACI Code provisions regarding the interpretation of core strength test results. New factors have been considered. These include core diameter, moisture content of core sample, core damage associated with drilling, in addition to the effect of aspect ratio that was previously considered in the former ACI edition (1998). According to the ACI 214.4R-03, the in-place concrete strength can be computed using the equation:

$$f_c = F_{l/d} \cdot F_{dia} \cdot F_{mc} \cdot F_D \cdot f_{core} \tag{5}$$

where f_c is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, $F_{l/d}$ is strength correction factor for aspect ratio, F_{dia} is strength correction factors for diameter, F_{mc} is strength correction factor for moisture condition of core sample, and F_D is the strength correction factor that accounts for effect of damage sustained during core drilling including micro-cracking and undulations at the drilled surface and cutting through coarse-aggregate particles that may subsequently pop out during testing.

The ACI committee considered the correction factors presented in Table 3 for converting core strengths into equivalent in-place strengths based on the work reported by Bartlett and MacGregor [6]. It should be noted that the magnitude of

Table 2 Mean values for factor $F_{l/d}$ according to ACI Code (1998) and ASTM.

	Specimen length-to-diameter ratio, l/d			
	1.00	1.25	1.50	1.75
$F_{l/d}$	0.87	0.93	0.96	0.98

Table 3 Strength correction factors according to ACI 214.4R-03.

List	Factors	Mean values
(1)[b]	$F_{l/d}$: l/d ratio	
	As-received	$1 - \{0.130 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Soaked 48 h	$1 - \{0.117 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Air dried[a]	$1 - \{0.144 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
	As-received	1.00
	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.
[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
A9																		
A10								■▲●										
A11																		
A12		●		●	●													
A13																		
A14		●		●														
A15		●																
A16	●♦																	
A17	♦																	
A18																		

● Diameter of steel bar.
▲ Distance of steel bar from nearly end of core.
■ Number of steel bars and spacing between bars.
♦ Distance of steel bar from vertical axis of specimen.

This brief review indicated that the various proposed relationships for correction factors are all nonlinear. It should be noted that the equations given by the Egyptian Code takes into account most variables that may affect the interpretation of the results; however, the code ignores the deterioration of steel–concrete bond that may occur and also the position of the reinforcement from vertical axis of core specimens.

Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

- For cores containing a single bar:

$$F_{reinf} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{core}^{0.015}} \quad (12)$$

- For core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect is assessed by replacing the term ($\Phi_r * r$) by ($\sum \Phi_r * r$ as follows:

$$F_{reinf} = \left[1 + 1.5\frac{\sum[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{core}^{0.015}} \quad (13)$$

where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

6.1.6. *Effect of moisture condition of core*

Results of about 100 cores indicate that the strength of cores left to dry in air for 7 days is on average 13% greater than that of cores soaked at least 40 h before testing. The strength of cores with negligible moisture gradient and tested after cutting is found to be 7–9% larger than that of soaked cores as shown in Fig. 20. The authors strongly recommend to use a correction factor accounting for moisture condition (F_m) equals to 1.09 and 0.96, respectively, for cores tested after 48 h soaked in water and for those tested after 7 days dry in air.

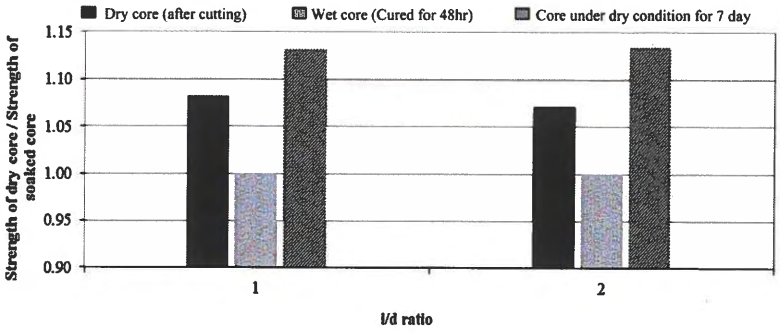

Figure 20 Effect of core moisture condition on core strength for different aspect ratios (l/d).